LABORATORY PRACTICE

RESEARCH · CONTROL · TEACHING

VOL. 8 No. 9 Published Monthly SEPTEMBER 1959

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15A.
~~Mr. Bass~~ 119
Mr. Cook 119
~~Mr. Watt~~ 117
Mr. Bishop 117
~~Mr. Glynn~~ 117

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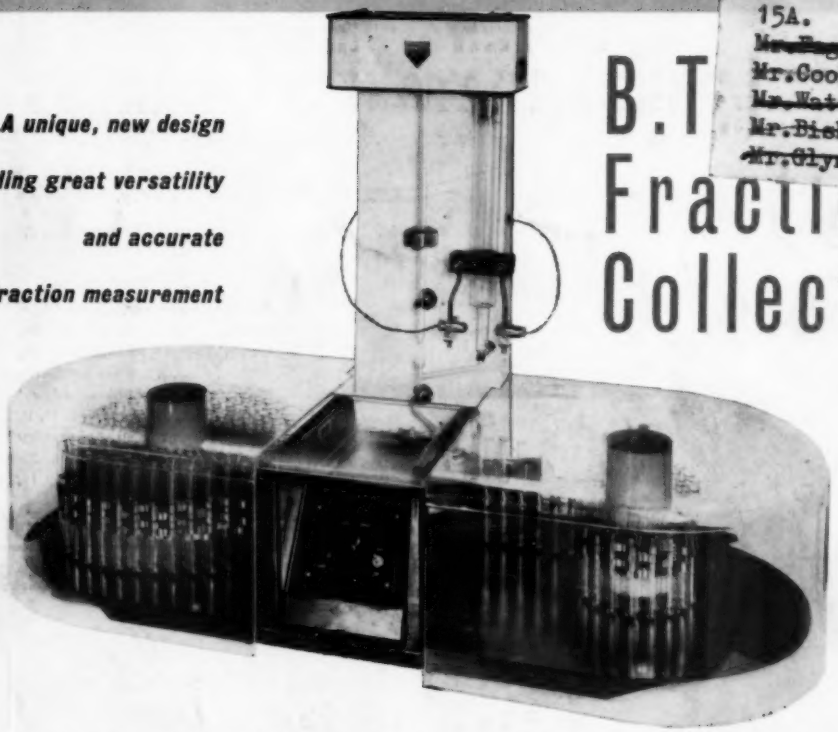

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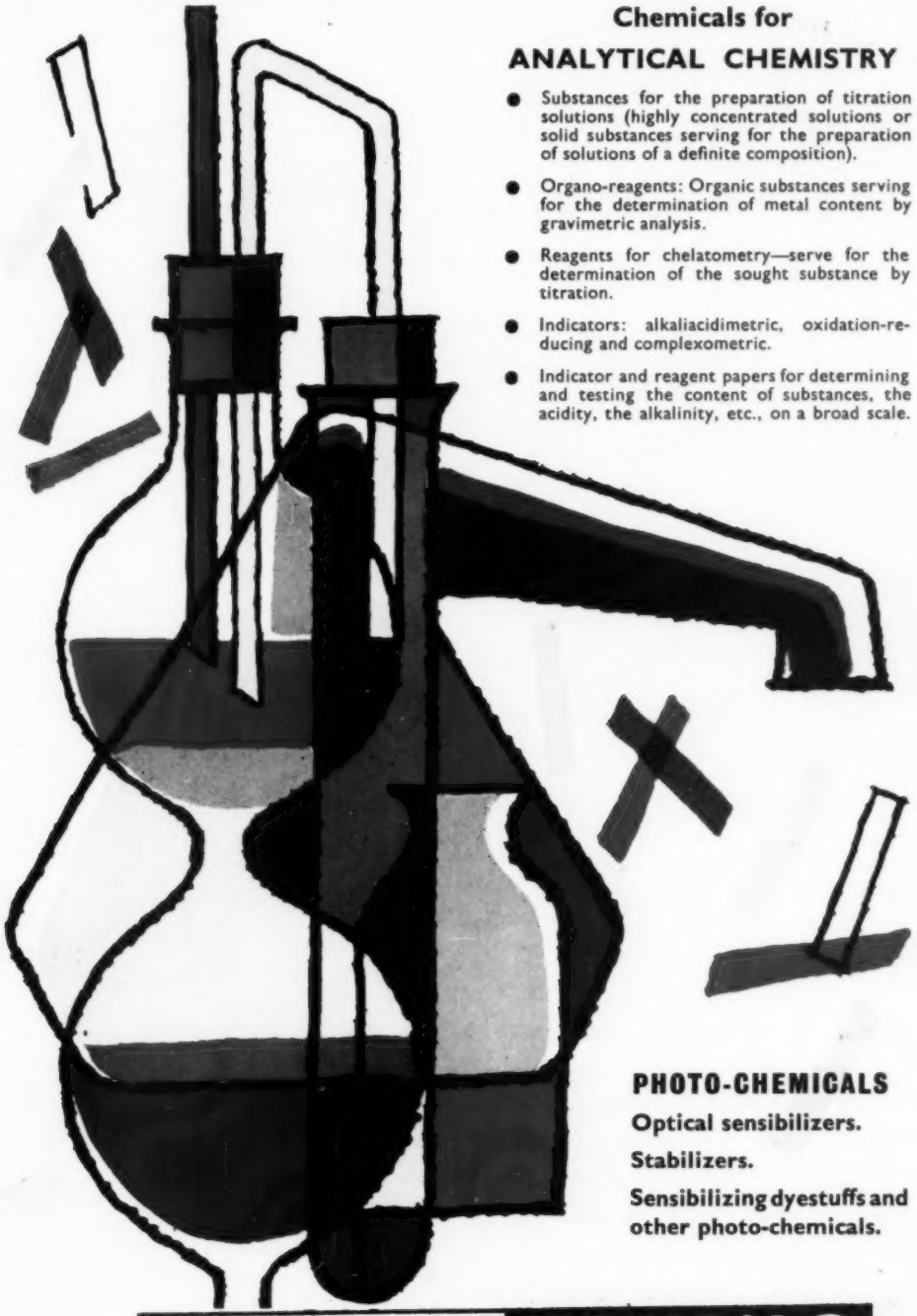

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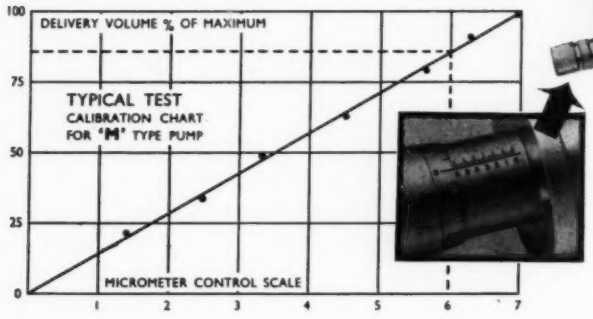

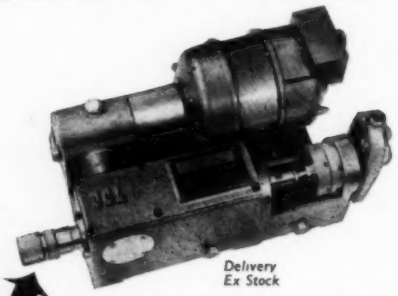

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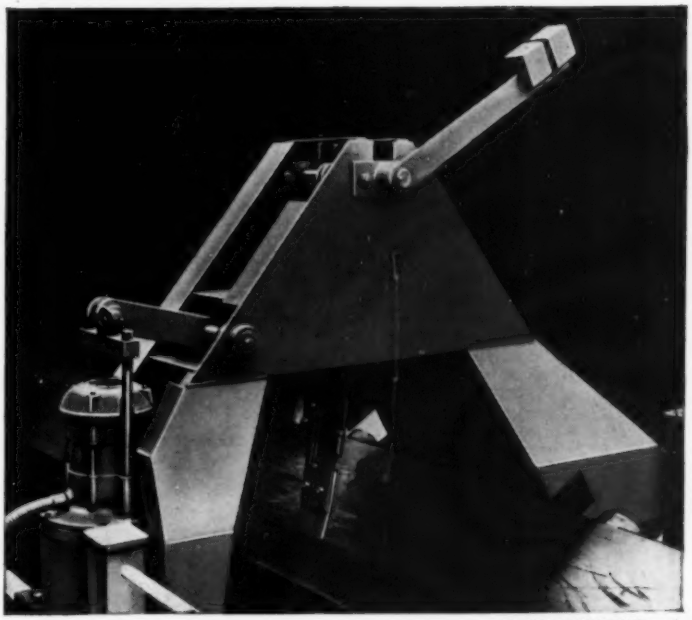

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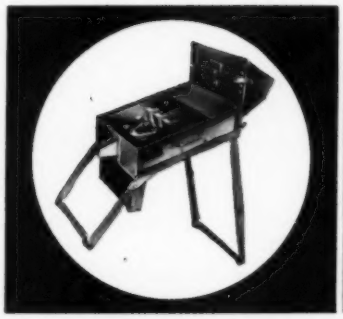

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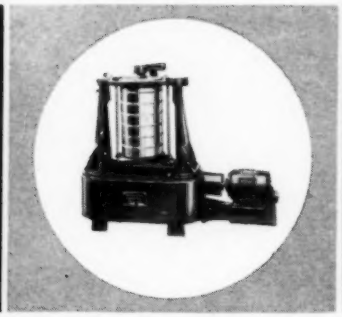

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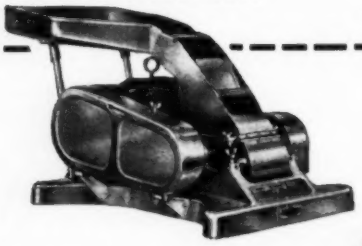

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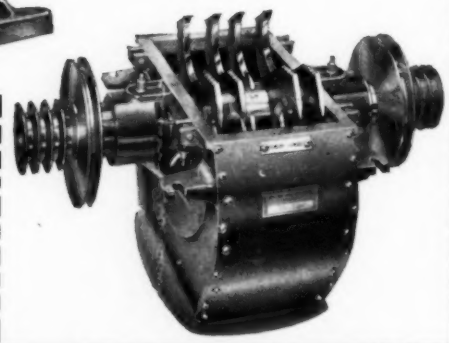

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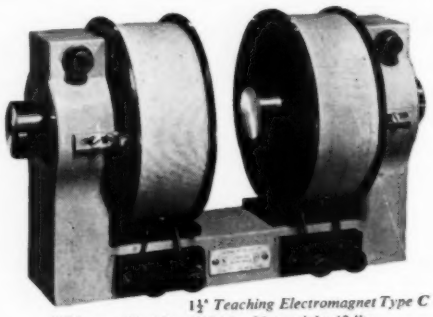

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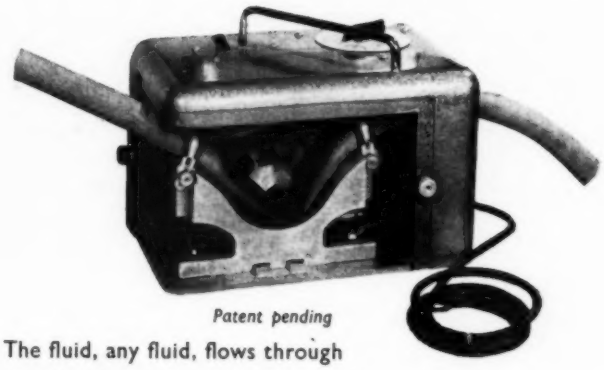

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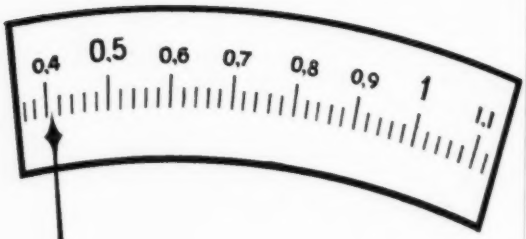

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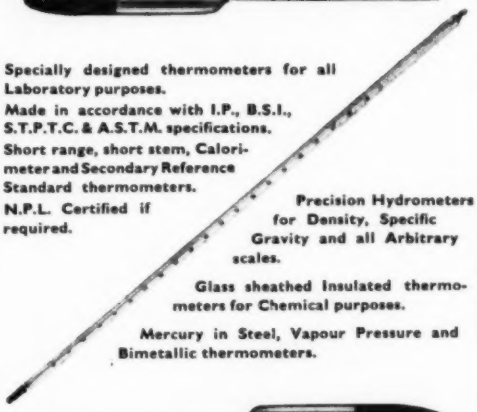

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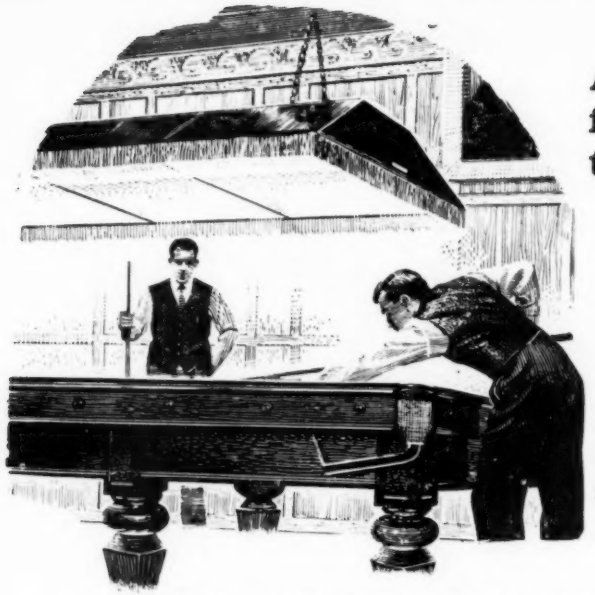

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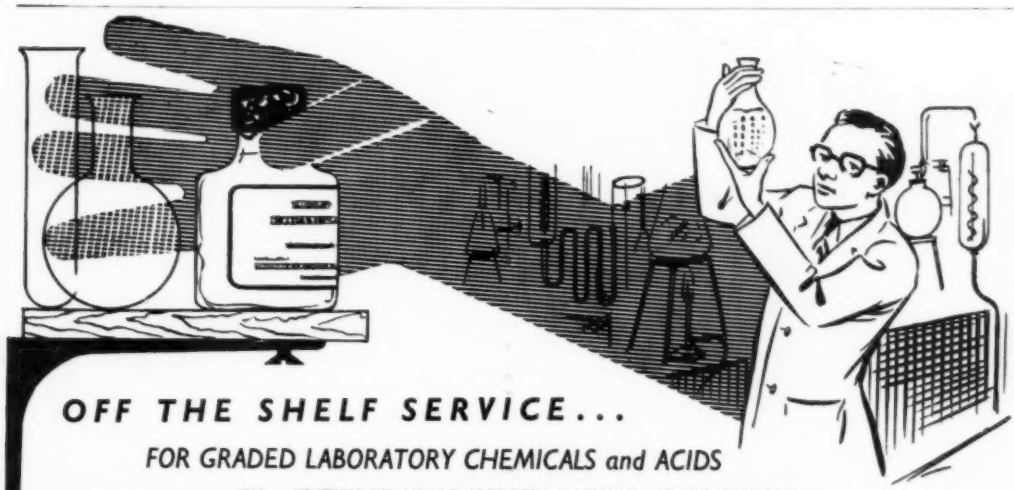

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CONTENTS

Page

EDITORIAL 287

LABORATORY EQUIPMENT TEST REPORT:

ELGASTAT MULTIPLAN B.107 289

ORIGINAL CONTRIBUTION:

INVESTIGATION INTO THE TITRATION ASSAY OF AMINOACIDS, Part I, *by S. Lewin* 292

ARTICLES:

PACKAGE TESTING, *by D. Watkinson* 296
TECHNICAL WRITING, *by E. H. W. Banner* . . 301

APPARATUS AND DEVICES:

AN APPARATUS FOR PERFUSING NERVE FIBRES, *by J. P. Heslop* 303
AN ELECTRIC SHOCKING DEVICE AS A LABORATORY AID TO FISH STUDIES, *by G. R. Fish* . . 304

BOOK REVIEWS 305
PILKINGTON'S LABORATORY EXTENSIONS . . 308
PREPARATION OF MOLYBDENUM CHLORIDES . 310
ADVANCES IN LABELLING MATERIALS, *by Frederick T. Day* 311
NEWS FROM THE BRITISH ASSOCIATION OF CHEMISTS 313
LABORATORY NOTEBOOK 314
LABORATORY EQUIPMENT AND APPLIANCES . 315
NEWS 318

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EDITORIAL

The Future of the Family Doctor

IT may surprise many to learn that of the 90,000 odd names on the British medical register only about 21,000 are engaged in general practice in Britain, or are what would be known in the old days as 'family doctors'. The structure of the family doctor system has undergone a complete revolution in the last few years. What was formerly one of the three learned professions of antiquity, or at least medievalism, has become a branch of the Civil Service, and some would say a Cinderella of the Service. Both the practitioners and the public hold mixed views about the new system. Some favour it, some are indifferent, some dislike it, and a few doctors felt so strongly about it that they forthwith abandoned medicine as a calling when the scheme came into being. Of the 69,000 not in practice (N.H.S.), about 9,000 occupy junior posts in hospitals, about 7,000 are consultants or specialists, about 2,000 teach in medical schools, about 2,000 are in local government service, about 600 in private practice, about 600 in government service, and about 400 are employed in industry. There are also a considerable number holding appointments in the Commonwealth and abroad. In the total of 90,000 there are about 11,000 women, many of whom have ceased to practise or only work part-time.

This ratio of only 1 in 4 for the general practitioners of an essentially practical profession may appear surprising to many of us; it is probable that in other professions a much higher proportion are in actual practice and in daily contact with the public. There are, of course, the usual exceptions, notably in architecture. The increasing control over building exercised by bureaucracy and the transition of traditional building to civil engineering have together almost exterminated the practitioner architect.

Whatever views one may have about the National Health Service, there are facts which are beyond dispute. The ordinary medical practitioner is financially worse off today than before the war when a professional man was comfortably off on £1,500 p.a. All professional men have probably lost financial and social status relative to the working classes because the latter now earn more and enjoy a higher standard of living than before the

war. Many doctors today can afford to run only a small car, and their wives have to act as receptionists and secretaries. When it comes to the luxuries of life many general practitioners are no better off than the unskilled workers among their patients.

A fall in standard of living and a lowering of social status relative to non-professional workers are serious matters for any professional man, and medical men are not the only ones who find themselves in this position. There is however a unique feature in the problem because no other profession can be compared with medicine in the family doctor sense. He automatically becomes the most important person present whenever a life is at stake. He is bound by a most stringent ethical code. He has all the disadvantages of a clerical calling without the advantages. He not only works long hours, but may be called on at any time of the day or night. He continually carries the responsibility of life or death, and is constantly reminded of the fact that one mistake, even an apparently trivial one, may end in disaster. The rest of us can realize a mistake and rectify it next day, but not the physician.

All these circumstances are well known to medical students, and must be regarded as the occupational risks of a noble profession. The selection of candidates today is searching and only the fittest and most capable survive and ultimately qualify. The typical doctor is inevitably a good specimen of manhood both physically and mentally, and is quite prepared to face a lifetime of genteel slavery for the sake of his profession. He would do this with a good heart if he felt that his knowledge and ability were being used to the fullest extent. The trouble today is that the family doctor spends far too much time on jobs that an intelligent unskilled worker could do, and far too little time on the practice of medicine. General practice should require the widest knowledge and most profound sagacity in the profession. There should be ample time and opportunity for refresher courses and 'follow-up' of interesting cases. The National Health Scheme inevitably encourages the 'fill in a form and pass him on' attitude, to the ultimate detriment not only of the patient but also of the doctor.

There are many aspects of our national life today which give rise to disquiet. Juvenile delinquency has reached an all-time peak, and today there are about 27,000 persons in prisons and Borstal institutions. Crimes against the person are numerous and are increasing. In 1958 there were two and a half million legal cases, of which 40 per cent were criminal. Even if we deduct the 60 per cent connected with motoring (mostly technical offences) the total remaining is staggering.

This state of affairs must be considered in relation to existing conditions. We now enjoy the highest ever standard of living, the greatest extent of education, universal suffrage, the virtual abolition of poverty, and privilege, in the old social caste sense, is fast disappearing. It is evident that prosperity, opportunity and freedom do not necessarily lead to the reduction of crime.

Many explanations for this unhappy state of affairs have been suggested. Leniency in the treatment of convicted persons, unselective immigration, the extensive employment of mothers, broken homes, the diminished influence of religion, the spoiling of children and many other factors have been singled out as responsible for the deterioration in morals. Whatever the explanation, there can be no disputing the facts. Poverty might be accepted as an excuse for enterprising and repressed youngsters, but young people get more pocket money and earn more now than they did 20 years ago.

We do not suggest for one moment that the National Health Scheme can be held responsible for the increase in crime. What we do suggest is that in these days of diminished parental responsibility more use could be made of doctors for social services in the highest sense of the term. Many people will not listen to religious exhortation today, but few would refuse to discuss their problems, medical or social, with the old type of family doctor. A worth while scheme along these lines would naturally be expensive, but what is the cost to the country in juvenile delinquency, wasted lives, and the criminal careers and prison sentences which inevitably follow the first appearance in the juvenile court unless there is some machinery to take things in hand? The probationary system is admirable, but it does not begin to function until the rot has started.

The diminished impact of religious and moral teaching today leaves a gap which might well be filled to some extent by a reversion to the old family doctor system, in which the medical adviser could be an interested friend and adviser on the great problems of life. Teachings based on dogmas which are thousands of years old may leave young people cold today, but the advice of the family doctor is based on personal experience and knowledge of human nature which are unobscured by any social convention and unfettered by any dogma. The sickroom is the one confessional where no lies are ever told.

Ship Hydrodynamics Laboratory

H.R.H. the Duke of Edinburgh will open the new Ship Hydrodynamics Laboratory of the Department of Scientific and Industrial Research, at Feltham, on Monday afternoon, October 19, 1959.

The new Ship Hydrodynamics Laboratory is an addition to the Ship Division of the National Physical Laboratory. It comprises a towing tank, 1,300 ft. long, 48 ft. wide and 25 ft. deep; a water tunnel with a measuring section 44 in. in diameter: a sea-keeping and manoeuvring basin 100 ft. sq., together with the necessary workshops for making model hulls and propellers, a vibration laboratory, and instrument laboratories for testing and calibration.

These new and up-to-date facilities for hydrodynamic research and development, designed to reproduce in the laboratory more nearly realistic sea conditions than has been possible in the past, will now be at the service of British shipbuilding. The main aim of the research will be to make it possible to design ships that can maintain high speeds in rough seas without danger and with a minimum of discomfort.

LABORATORY EQUIPMENT TEST REPORT—No. 38

ELGASTAT MULTIPLAN B.107

Manufacturers: Elga Products Ltd., Lane End, Bucks.

Price (basic): £28

Description

The Elgastat Multiplan is a self-contained and complete unit for the execution of many ion exchange or deionization processes met in the laboratory. Essentially it comprises two Plexiglas columns, one embodying an interface for mixed bed regeneration. The columns are vertically mounted, held in position by clips on an acid-resistant plastic chassis. Both columns are fitted with flow control valves and detachable filters.

Inherent in single bed deionization is the mixing of the anion and cation exchangers after regeneration. For this purpose an efficient air pump with non-return valve is provided.

The columns unclip for cleaning and sterilizing. Flow lines suitable for the many operation and regeneration cycles are supplied.

For quality control a conductivity cell and monitor are advisable. Provision is therefore made for a matched line cell and meter.

Applications

Recovery of metallic ions from solution, the separation of rare earth metals, and the recovery of noble metals from waste.

Recovery and purification of organic compounds, including dyestuffs and vitamins.

The isolation and concentration of pharmaceuticals.

Removal of citric acid from fruit wastes, and the treatment of wines and fatty acids.

Removal of acids from solution.

Decoloration of solutions.

Purification and the separation of radioactive effluents and wastes.

Separation and analysis of materials in solution by ion exchange chromatography.

Balancing of boiler feed water—conductivity water.

The control of fluoride content in drinking water.

Balancing and conditioning of blood and plasma.

The application of the mixed bed ion exchange technique is well known for the production of water of very high purity. By using the mixed bed technique even very unfavourable exchange equilibria may be driven to completion. The effluent is virtually H_2O and specific resistance may approach 16 megohm cm.

The preparation of distilled quality water for routine laboratory work is possible by the two bed method. This will give a specific resistance of 200,000 ohm cm.

Constructional and Technical Data

Frame: Warerite double backed

Columns: Plexiglas, second column with interface

Flow control valves: Pyrex

Hand operated air pump: Black plastic

Pipe Lines: Polythene

Retainers for Column: Spring clip acid resistant

Filters: Plexiglas/Polythene cloth combination

Conductivity Meter (optional accessory): Elga type Y.1002

Conductivity Cell: As above.

Maximum operational bed volume per column: 500 g. (57 cc.)

Flow rate with column half-filled with resins: Up to 15 litres per hour depending on input pressure.

Operation

The columns can be used independently or in series, and there is space for backwashing and remixing of resins. Flow rates are controlled accurately by valves. The flow may be directed as the process requires, a most important aspect for mixed bed regeneration *in situ*. Complete flooding of the resins and absence of channelling or clogging is ensured by the use of filters of a special design.

Mixed bed cycles and regeneration are effected in the column which incorporates the interface. Separation of the exchangers is carried out *in situ* in this column. The interface admits or discharges regenerants and rinse water respectively. Intimate remixing of the anion and cation resins is done by the air pump.

Change-over from one resin to another can be made quickly by unclipping and inverting the column.

Stage control for the regenerating cycle and quality check for the operation cycle are facilitated by conductivity measurements. Line cells to fit the existing flow lines and conductivity meter are optional extras.

Provision is made for the recovery of materials absorbed on the resins by passing a suitable eluting agent through the column.

Examination of the Multiplan

This is a versatile ion exchanger outfit designed for investigating and carrying out a wide variety of processes. Each of the two columns takes about 250 g. resin. The apparatus is therefore of suitable size for small pilot plant work.

A large number of ion exchange processes can be carried out in equipment such as this and many suggestions for its use are made in the literature supplied with the apparatus. Many more can be found in books such as 'Ion Exchangers in Organic and Biochemistry' edited by C. Calmon and T. R E. Kressman (Interscience, New York 1957) and 'Ion Exchanges in Analytical Chemistry' by O. Samuelson (Wiley, New York, 1953).

In these tests of the Multiplan the following four processes which utilize different types of resin have been examined:

1. Use of mixed strong cation and strong anion exchangers to purify London tap water by the single column method, with regeneration of the resins in the column designed for this purpose.
2. Use of separate columns of strong cation and weak anion exchangers to produce purified water of lower quality from tap water.
3. Preparation of purified quinine hydrochloride from a crude specimen of quinine tannate.
4. Separation of a glycoside fraction from an extract of senna leaf.

Single Bed Water Purification

About 250 g. mixed strong anion and cation exchangers was slurried into the column fitted for mixed bed regeneration. This gave a resin bed volume, including water in contact with the resin, of 325 ml. London tap water was passed down through the column and then through the line conductivity cell and the specific resistance was continuously observed on the meter which is available as an optional extra, with the apparatus. This meter was checked against a standard resistance bridge using water samples of specific resistances 0·1 and 1·0 megohm cm. respectively, and was found to be reasonably accurate.

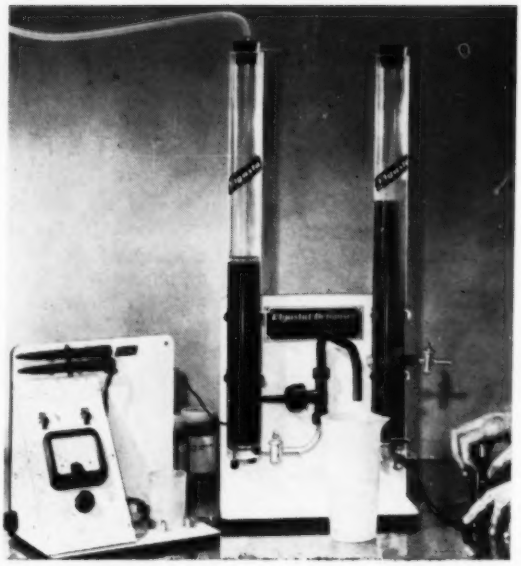
After putting in the column, the resins were mixed thoroughly by blowing air up through the resin bed by means of the hand operated air pump, they were then backwashed gently with an upward flow of tap water. The down flow of tap water was started at a rate of 10 litres per hour. The first runnings had a specific resistance of 1·5 megohm cm. and this rose to 4 after 2 litres had been collected, the resistance fell below 1 megohm cm. after 10·5 litres had been drawn. These results give an efficiency factor,

$$\frac{\text{volume of purified water}}{\text{volume of resin bed}}$$

of 32·3, a normal sort of figure for a mixed resin bed used to purify London tap water. As usual from this type of column, the pH of the water was almost exactly neutral, that is pH 7.

The first attempt to regenerate the resins in the column was not a great success. Considerable care is necessary with a small column to avoid bringing the regenerant solutions into contact with the wrong resins. However, a second attempt was successful and once the technique has been mastered it is quite straightforward. From the regenerated column, 10 litres of purified water of resistance greater than 1 megohm cm. was obtained.

The regeneration, as always, is a tedious and messy operation, in fact, it takes as long to regenerate a column of this size as to regenerate a large demineralizing plant. The main value of this part of the equipment is for demonstrations of the mixed bed process rather than for the production of purified water.



Elgastat Multiplan B.107.

Two Column Water Purification

When the cation and anion exchangers are placed in separate columns, regeneration is simplified but the quality of the purified water is considerably reduced. It is hardly worth using the strong anion exchanger in this two column process and a better yield of purified water is obtained by using a weak anion exchanger, as this does not remove carbon dioxide. The strong and weak anion exchangers have similar capacities per unit volume, but as more than half the anions of hard water are carbonate or bicarbonate, the weak exchanger, which is not affected by these anions because it does not remove them, can deal with twice as much tap water as the strong one.

For mixed bed demineralization to give water of the highest purity, the best proportions of strong anion to strong cation exchanger is about 2:1 by volume. However with the weak anion-strong cation exchanger combination, equal volumes of the two resins can be used.

Equal bed volumes of the two resins were prepared in the separate columns, each was approximately 310 ml. Tap water was passed down through the strong cation exchanger and then down through the weak anion exchanger, finally passing through the conductivity cell. The specific resistance rose to a maximum of 0·28 megohm cm. and a total volume of 32 litres of purified water of resistance over 0·09 megohm cm. was collected. A considerably larger volume of less pure water could have been obtained as the resistance dropped quite slowly. The efficiency factor in this case was 51, appreciably greater than with the mixed resins but of course the product was of lower quality. The pH of the water obtained by this method was 5.

Purification of a Crude Quinine Salt

About 16 g. crude quinine tannate was shaken with 200 ml. ethyl alcohol. Part of it dissolved to give a dark brown solution, however a considerable quantity remained undissolved. About 40 g. strong anion exchanger was added to the mixture to remove some of the tannins, and so enable more of the quinine to dissolve. The alcoholic extract was filtered and mixed with an equal volume of water. This was necessary because absolute alcohol causes some damage to the Plexiglas columns, resulting in a 'crazing' of their inner surfaces. This does no great harm but it rather spoils their appearance.

The extract in 50 per cent water-alcohol solvent was passed through the two columns in series. The first column contained strong anion exchanger in the hydroxyl form, previously soaked in water-alcohol solvent while the second contained weak cation exchanger in the hydrogen form, similarly treated. In the first column the anionic tannins were removed to give a solution of quinine base and this was absorbed on the second column. The extract was washed through with 500 ml. solvent which carried some neutral colouring matter right through the two columns. The second column was then separated and washed with a further quantity of solvent, until the washings were colourless. The purified quinine was eluted from this column as quinine hydrochloride, by means of hydrochloric acid. A straw coloured solution was obtained from which the salt was separated by evaporation.

At this point, it is worth considering what solvents can safely be used in these Plexiglas columns. According to the literature, this material is completely unattacked by 10 per cent nitric acid, 30 per cent hydrochloric acid, 25 per cent sulphuric acid, 30 per cent ammonia solution, concentrated sodium and potassium hydroxide solutions, 0·1 N potassium permanganate, sodium hypochlorite solution, glycerol, 40 per cent formaldehyde solution, glycol, petroleum ether and paraffin. It is swelled or crazed by glacial acetic acid, alcohols, carbon disulphide, carbon tetrachloride, chloroform and diethyl ether. It is dissolved by acetone, ethyl and amyl acetates, benzene and trichlorethylene. According to the author's observations, Plexiglas is little affected by 50 per cent water-alcohol though it is probably best to work with as low an alcohol content as possible in the mixed solvent.

For the purpose of handling organic solvents in general it would be useful to add a Pyrex column to the Multiplan outfit.

Separation of a Glycoside Fraction from Senna Leaf

The Multiplan is well designed for resolving extracts of biological materials into anionic, cationic and non-ionic fractions. For this purpose, the extract is passed through anion and cation exchange columns in series. The material retained by the resins can then be fractionally eluted from the columns by elutants of varying pH and ionic strength. This procedure has been used with great success in resolving mixtures of amino acids and nucleotides. For this type of work the fine, chromatographic grades of resin are best, these require a certain amount of backwashing to remove very fine particles from them.

In this experiment only those glycosides containing carboxyl groups and therefore anionic, were of interest and therefore only the anion exchanger column was used. The glycosides are easily hydrolysed by both acids and alkalis, it was therefore decided to use the strong anion exchanger in the bicarbonate form.

One hundred grams of this exchanger, which is supplied in the chloride form, was put into a column and converted to the bicarbonate form by passing a saturated solution of sodium bicarbonate through it. It was washed with water and 50 per cent water-alcohol solvent. Then 200 ml. of a dark brown extract of senna leaf in this solvent was put on the column and allowed to flow down through the resin bed which was finally washed with solvent until the washings were almost colourless. In this way neutral colouring matter was removed.

The column was eluted with a 5 per cent solution of ammonium chloride in 50 per cent water-alcohol and this gave a deep brown effluent containing the required glycoside. Elution was continued until the effluent was colourless. Further coloured fractions were obtained by elution with sodium carbonate solution, dilute acetic acid and finally hydrochloric acid, the final fraction had a bright green colour.

This provides a neat method which with further development should be suitable for preparing relatively large quantities of this glycoside fraction.

Urine and Plasma Analysis

These analyses were not investigated in the tests but the Multiplan should prove well suited for them. Details of this type of work are given in 'Ion Exchangers in Organic and Biochemistry'.

Conclusions

The Multiplan is particularly well designed for demonstrating the use of different resin combinations in the purification of water and for showing the method for regenerating mixed resin columns. It would be a useful addition to the equipment of colleges teaching chemical technology.

The success of ion exchange in water purification has perhaps overshadowed the many other applications of this versatile process. The Multiplan should prove useful for investigating other purification processes and is of a size suitable for small pilot scale work.

Appointment of Chief Scientific Adviser

Dr. H. R. Barnell, M.A., Ph.D., B.Sc., M.I.Biol., has been appointed as the Ministry's Chief Scientific Adviser (Food). He succeeds Dr. Norman Wright who joined the Food and Agriculture Organization of the United Nations in February 1959.

Dr. Barnell was transferred from the Dehydration Division of the Ministry of Food to the Scientific Adviser's Division in 1946 and became deputy to the Chief Scientific Adviser in 1950.

ORIGINAL CONTRIBUTION

INVESTIGATION INTO THE TITRATION ASSAY OF AMINOACIDS

by S. Lewin, M.Sc., Ph.D.

Physical Chemistry Laboratory, South-West Essex Technical College, London, E.17

PART I

THE volumetric approach to the determination of aminoacid concentration in aqueous solution is complicated by the very weak acid nature of the aminoacids. The purpose of this paper is to consider briefly possible volumetric alkali titrations of aminoacids, and in particular the uses of the formol titration (or Sørensen titration) in the light of work carried out by the author.

Volumetric acid-base titrations require a corresponding acid-base indicator which generally changes colour over a pH range of c. 1·8 pH units. To use the indicator effectively, it is essential that the plot of pH v. alkali volume at the end-point of the titration should be flat, i.e. $(dpH/dB) \rightarrow \infty$, and that this flat range should practically cover the above indicator range. When a weak acid, having a suitable pK value and with a titration end-point in the region of pH 8 to pH 10, is used, phenolphthalein may be used as an indicator, and then the equivalent quantity of alkali required for neutralization will agree with the calculated one. If however the titration end-point is in the region above pH 10, the flat range is absent and the plot follows the pattern given in Fig. 1.

The absence of the requisite flattening is due to the titration end-point of the acid overstepping into the titration curve of water. The water present in the aqueous solution may for present purposes be considered as a very weak acid, the titration curve of which becomes significant above pH 10. For practical purposes we have therefore two acids with different pK values, the end of the titration curve of the first overlapping the beginning of the second.

Consider in this light the titration of a quantity of a simple aminoacid, such as glycine, with sodium hydroxide. Here the requisite flattening of the pH v. alkali volume plot is not obtained when the equivalent quantity of the alkali has been added, because the end-point is in the region of pH 11 (Fig. 1). In analysing the conditions for calculation or direct determination of the titration end-point, several possibilities emerge:

1. *pK value calculation.*—The pK value of the acid is determined by substitution of the titration data in the region below pH ~9·5 into the Henderson-Hasselbalch equation, followed by calculation of the pK value. The amount of alkali (X) required to raise the pH of the solution equal to that of the pK value is noted. By the Henderson-Hasselbalch equation, the quantity (X) is equal to *half* the quantity of alkali required to neutralize the acid. However, it is essential to evaluate the pK value to a high degree of accuracy*.

2. *The differential plot method.*—Examination of the curve in Fig. 1 shows that the curvature of the titration

*It should be remembered that the pH scale is a logarithmic one and that the buffering capacity is highest at the pH = pK point. A simplified method of calculating pK values has been developed by the author. It will be described elsewhere.

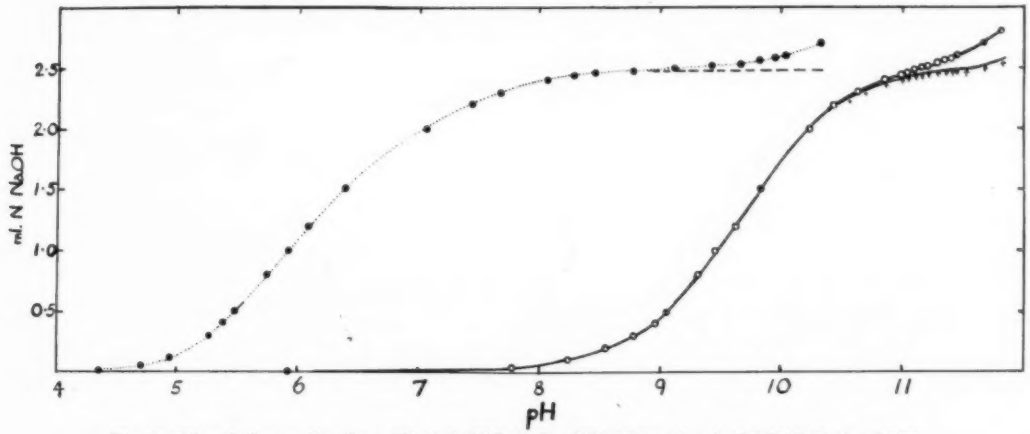


Fig. 1. pH variation on titration of 5 ml. 0·5 M glycine (diluted five times) with N NaOH at 25°C.
O———O 5 ml. glycine plus 20 ml. distilled water (CO_2 free).
● · · · · ● 5 ml. glycine plus 5 ml. (37 per cent) formaldehyde plus 15 ml. distilled water (CO_2 free).
— — — — Corrected formol titration, using direct blank water correction.
↑↑↑↑↑↑ Corrected glycine titration curve, using direct blank water correction.

curve changes direction after the end-point has been reached. Hence, the plot of ($\Delta pH/\Delta V$) v. V, where V is the volume of alkali used, should result in a maximum which gives the end-point with a comparatively high degree of accuracy. This method does not seem to have been used previously in *direct* aminoacid-alkali titrations, though it has been utilized by Dunn and Loshakoff (1936a, b) in the *formol* titration for accurate end-point determinations. The partial neglect of the method may have been due to the fact that, until the last five or ten years, only the sodium glass electrodes were in general use and these were accurate only up to c. pH 9·5, while the direct aminoacid-alkali and formol titrations end-points are in the region over pH 10·5, and in the region of pH 7 and upwards respectively. However, the development of lithium and other stable glass electrodes capable of giving good results in the higher pH ranges now permits completion of titration curves in *direct* aminoacid-alkali titrations. We have investigated the applicability of this method to direct aminoacid-alkali titrations using lithium glass electrodes, thermojacket systems (Lewin, 1953, 1958) and internal-bridge calomel electrodes (Lewin, 1954), and obtained quite accurate results. Differential plotting results obtained for the titration of 0·5 M glycine with N NaOH are given in Fig. 2.

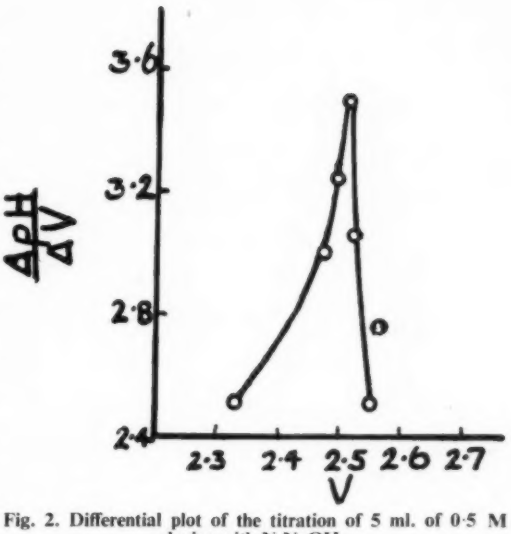


Fig. 2. Differential plot of the titration of 5 ml. of 0·5 M glycine with N NaOH.

3. *The water correction method.*—In the water correction method, the amounts of alkali or acid required in a blank titration of water to attain specified pH values are recorded and equivalent corrections are made in the aminoacid titration curve*. Such corrections are, of course, of fundamental importance in the evaluation of the theoretical titration curves of single acid-base groups whose pK values require titrations in the pH region above c. pH 10 and below c. pH 4. For accurate corrections the following relation developed by Jordan and Taylor (1946) should be used

$$V'_b = V_b \left(\frac{V_s + V}{V_s + V_b} \right) \text{antilog } 0{\cdot}5\,(\sqrt{I} - \sqrt{I_b})$$

where V_s = volume of the weak acid being titrated
V = volume of alkali required to titrate V_s ml. of pure water to a specified pH
V_b = volume of alkali required to titrate V_s ml. of the weak acid to the specified pH
V'_b = the correction, in ml., to be deducted from V, giving the quantity of alkali used to neutralize the acid
I = the ionic strength of the resulting aqueous solution of NaOH at the specified pH
I_b = the ionic strength of the titrated weak acid solution at the specified pH.

This formulation can be used for the direct titration of an aminoacid without the use of formaldehyde. However, the formulation assumed that the activity coefficients of the anions of aminoacids are given accurately by the Debye-Hückel equation for ionic strengths below I = 0·01. Unfortunately, this assumption is not always valid (see the Appendix on Ionic Strength in 'The Solubility Product Principle: An Introduction to its Uses and Limitations' by S. Lewin 1959). An added complication is the uncertainty as to the exact contribution of the zwitterion to the overall ionic strength of the medium. Further, calculations involved in the application of the equation can consume considerable time. While these are essential for the determination of the shape of the titration curve with a high order of accuracy, for convenience's sake it is often preferable to use other methods which, so far as mere titration end-point determinations are concerned, are far more rapid and require fewer assumptions. It is possible to use blank correction values without application of the above equation. The result, on substitution into the aminoacid-alkali titration data, is highly approximate, but in some cases it gives a small range flattening of the titration curve at the end-point. (See the arrowed section in Fig. 1.) It is interesting to note, however, that if such a direct blank correction is employed in the *lower* pH ranges attained in the formol titration, the flattening at the end-point is extended considerably.

4. *The formol (or Sørensen) titration.*—This method consists of titrating the given solution of the aminoacid after addition of formaldehyde. The titration curve is then displaced to the acid side of the pH scale, thus

*The *uncorrected* blank substitution method was advocated originally by Cohn, Gross and Johnson (1919-20) and Tague (1920), and was used extensively by Kirk and Schmidt (1929), by Albert and Goodacre (1942) and by others. However, Cohn and Berggren (1924-5) pointed out that a simple blank substitution method was insufficiently accurate because, at a specified pH, the ionic strength of water was not equal to that of the weak acid solution (owing to the alkali associated with the salt in the latter solution).

Schmidt (1938) and Cannan (1942) advocated an experimental determination of the correction which involved a considerable number of determinations and calculations. Jordan and Taylor (1946) have, however, evolved the equation given here the application of which is less time consuming.

making possible separation of the aminoacid and water titration curves. Consequently, if sufficient formaldehyde is added, the flattening of the titration curve in the end-point region may be obtained, thus making possible the use of phenolphthalein as the end-point indicator.

The method was originally advocated by Sœrensen (1907) and was based on the observations made by Schiff (1900, 1901). It was extensively investigated by Birch and Harris (1930a, b). Levy (1933, 1934, 1935) developed the first systematic treatment of the formol titration in terms of reversible interactions of the free $-NH_2$ groups with one and two molecules of formaldehyde. There is no doubt that this overall interpretation holds in the case of simple aminoacids and in the initial stages of the interaction. However, there is considerable evidence that the mechanism is different when the above conditions do not hold.

The fundamental requirement involved in the utilization of the formol titration is that the aminoacid titration curve be displaced towards the acid side of pH to an extent sufficient to ensure that the flattening range, viz. $(dpH/dB) = \infty$, should take place before pH 10. This condition is affected by the following factors:

(a) *Formaldehyde purity.* The formaldehyde added should not contain acid in any significant quantity, as this would affect the end-point titre and the flattening range. Formaldehyde solutions (37 per cent to 40 per cent) are available from manufacturers or distributors. When freshly prepared, they are acid-free, but the time interval between production and delivery, and laboratory storage duration, may run into months. Several checks in this laboratory have shown that, under aerobic conditions and starting with acid-free formaldehyde, formic acid formation was cumulative and sufficiently significant after two months standing to affect the titre. Polymer formation is also encountered and can be troublesome. This may take place even within two weeks of purification of the formaldehyde. However, for the final titre purpose it is not necessary to know the exact formaldehyde concentration, and provided the quantity of the white deposit at the bottom of the bottle is not outstanding, polymer formation may be disregarded.

Some laboratory workers test the formaldehyde solution for acidity by using litmus paper. However, it is preferable to check the pH value by using glass electrode determinations.

Formaldehyde may be purified by distillation. However, this is a cumbersome method. It is preferable to use ion-exchange deacidification methods.

(b) *Formaldehyde concentration.* The pH depression value increases with rise in formaldehyde concentration. Thus, in the case of glycine, having pK value of 9·6, formaldehyde additions giving 9 per cent, 10 per cent and 16 per cent concentrations, result in the experimental pK becoming respectively 5·9, 5·6 and 5·4. The value of the depression depends also on the formol equilibrium constant values which vary considerably from one aminoacid to another. Now, it is desirable to have pH depressions large enough to stop the aminoacid titration overstepping into the water buffering range, and therefore it might appear, at first sight, that the highest possible formaldehyde concentrations should be used. Unfortunately, pure formaldehyde behaves as a very weak acid with a significant buffering range which begins at pH>7 when formaldehyde concentrations of over 10 per cent are used. Such large concentrations are bound therefore to cause significant errors in the aminoacid titre. For this reason, Levy recommended that the overall formaldehyde concentration should be kept within 6 per cent to 9 per cent. However, with aminoacids having low formol equilibrium constants this results in titration displacements which give unsatisfactory end-point flattenings. Phenolphthalein is then not quite satisfactory as an indicator as it may give an error of 0·5 per cent more. With such acids it is advisable to follow the formol titration by glass electrode pH determinations and to employ the differential method of plotting $(\Delta pH/\Delta V)$ v. V, as used by Dunn and Loshakoff (1936a, b). This method, as has already been pointed out, gives very good results.

(c) *Aminoacid concentration.* The greater the aminoacid concentration, the greater the amount of alkali required for the titration values. When, therefore, high aminoacid concentrations are used in the region occupied by both aminoacid and water buffering, the

$$\text{ratio } \frac{\text{alkali required for aminoacid titre}}{\text{alkali required for water titre}} \text{ increases.}$$

It follows that increase in aminoacid concentration enhances a greater percentage accuracy in aminoacid titre determinations. This is easy to achieve in a number of aminoacids which are highly soluble.

(d) *History of the aminoacid solution.* Aminoacid solutions which have been stored for some time at room temperature—under bacteriostatic (under toluene) and aerobic conditions—undergo decomposition, particularly in the presence of some alkali. This was noted by Holden and Freeman (1931) and by Wadsworth and Pangborn (1936). This was confirmed using glass electrode pH determinations by Lewin (1956a, b), Lewin and Kosinski (1958) and Lewin and Fox (1956) who found that rise in temperature accelerated the decomposition considerably. Lewin (unpublished observations) confirmed chromatographically that such aminoacid solutions undergo extensive decomposition with rise in temperature. Hence, unless it is possible to store the aminoacid solutions under anaerobic conditions in a refrigerator, titration should be carried out as soon as convenient.

It should be remembered that aminoacid solutions provide a nutrient medium for bacteria and fungi. It has been noted time and again in this laboratory that aminoacid solutions, which were not kept bacteriostatic or sterile, developed bacterial and fungal growths when the aminoacid solutions were concentrated (molar solutions) within a week at room temperature.

(*To be continued*)

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PACKAGE TESTING

by D. Watkinson, B.Sc.

Reed Paper Group (Group Research)

THE purpose of package testing is to determine, by means of laboratory tests, the performance of a package under the particular conditions of transport. The conditions during transport will vary tremendously both in the natural atmospheric hazards and the mechanical hazards of rough handling, depending on the destination and also the size, shape and weight etc., of the package. It is therefore impossible to lay down rigid rules and each individual package must be considered as a separate problem.

The tests may be carried out either on the package itself or on the materials from which the container is constructed.

Testing of Materials

Under this heading, a very wide range of tests is available, but in most instances the results cannot be used to give any definite information on the performance of the package in practice. Everyone in the packaging field is well aware of the difficulty of specifying, in terms of *bursting strength* and *tensile strength* etc., the necessary qualities required of materials, such as paper and board, to produce a satisfactory package. The tests which are normally carried out are as follows:

Tensile Strength
Bursting Strength
Folding Endurance
Tearing Strength
Puncture Resistance
Crush Resistance
Rubproofness
Dynamic Tensile Strength.

These can give a great deal of information on the quality of the material but difficulty arises in correlating the results with the behaviour of the final package. This may best be illustrated by the results of a comprehensive series of tests, which were carried out at P.A.T.R.A. (Allen and Paine 1951.)

A range of paper bags was subjected to drop tests. It had already been found that the drop tests correlated well with the known performance of bags in practice. As a result of the drop tests, the various papers tested were allotted a 'score' denoting the quality of the bags made from each paper. The range of papers included both Kraft and sulphite papers.

The range of papers was then subjected to all the standard paper tests (tensile, burst, tear, etc.) and the papers graded in order of strength on the basis of each test. Apart from the dynamic tensile tests, none of the results correlated with the results obtained from the drop tests. The papers placed in order of tensile strength or bursting strength did not correspond with the order obtained from the drop tests. From the results of these tests it appeared therefore that the fact that one paper had a higher tensile or bursting strength than another did not necessarily mean that it would make a stronger bag. This also applied to all the other normal paper tests. In the case of the dynamic tensile tests, however, the results obtained in the *cross direction* of the paper correlated very well with the results of the drop tests. The fact that the tests on the paper in the *cross direction*, rather than the *machine direction*, were the more important, was probably due to the fact that in bags made on a normal bag-making machine the cross direction of the paper and the bag is the one which takes the greatest load, when the full bag is dropped in a vertical position.

Initially, the advantage of the dynamic tensile tester appeared to be the fact that the load was applied rapidly, which was more in keeping with the conditions occurring in practice, when the bag was dropped, than the low rates of loading obtained with the other instruments. Further investigation, however, revealed another important factor. Examination of the results obtained on the normal Schopper-type tester showed that on multiplying the breaking load by the extension-at-break, the resulting figures gave good agreement with those obtained on the dynamic tensile tester and also correlated with the results obtained from the drop tests. This product is in effect a measure of the 'work' done in breaking the paper.

It would appear therefore that the advantage of the dynamic tensile tester is not solely in the higher rate of loading but in the fact that it measures the 'work' required to break the paper rather than the load. Other tests which measure this quality also appear to correlate better with practical performance.

A great deal of interest is now being taken in the *work value*, particularly on the Continent, and apparently it has been used for a number of years in Australia where it is called *resilience*. It might be defined as the ability of paper to withstand strain, and it is probable that it will find increasing usage in the future.

Some of the other laboratory tests have been found useful in comparing the properties of materials to meet specific requirements but it has not been possible to carry out sufficiently extensive tests to establish a correlation.

In the use of papers on twist wrapping machines, for wrapping items such as sweets and chocolates, considerable difficulty has often been experienced due to tearing of the paper during the actual twisting operation. It has often been found possible in these instances to differentiate between 'good' and 'bad' papers by

measuring the extension-at-break on the Schopper-type tensile tester. It would appear probable that the quality of such papers could best be specified and maintained by specifying this 'extension' rather than any other properties.

In other high-speed wrapping operations the 'stiffness' or 'flexibility' of the paper is often found to cause trouble, and in some instances it has been found possible to differentiate between 'good' and 'bad' papers by measuring the 'droop' of a strip of paper, which is clamped at one end. A strip of paper half in inch wide is clamped horizontally so that a length of six inches is protruding at one side. The 'droop' of this strip is then measured from the end of the strip to a vertical line passing through the clamp. The clamp is then turned through 180° so that the droop can also be measured on the other side and thus counteract any natural curl of the paper strip. The average of these two readings is taken as the result.

For thicker papers and boards it is not always possible to measure the 'droop' of a strip, and under these circumstances a system, which applies a load to the centre of a strip of material supported at two points, appears to give fairly good correlation. This test has been found useful on board for cartons which are used on automatic machines.

These last three tests are of course purely comparative and it is essential to carry out a preliminary investigation in order to determine the necessary limits required under the particular circumstances.

In addition to the tests on materials to determine their mechanical properties there are those designed to assess the resistance to water, water vapour, gas, grease, etc.

Water resistance is normally measured by the Cobb test, in which the specimen is subjected to a constant head of water, over a given area, for a fixed period of time, and the water uptake is measured by weighing. This test does however require a predetermined standard to be set as the conditions of test are purely arbitrary.

Measurement of water vapour permeability of the sheet material can be carried out by the standard method. The material is sealed into a dish filled with calcium chloride which is then stored in a cabinet at controlled temperature and humidity and weighed at intervals. The increases in weight are plotted against time and the gradient of the resulting line used to calculate the W.V.P. in g./sq. m./24 hr. It is however, not possible to calculate the resistance of the final pack from the results, owing to the fact that such resistance will frequently be determined by the efficiency of the closure and the deterioration of the material due to creasing and handling. It is as well always to bear in mind that for products of high moisture content a good water vapour barrier may have disadvantages, as the moisture is thereby trapped inside the pack and changes in temperature may cause condensation to occur, with resulting damage to the contents. Examples of this have been found with commodities such as bread, confectionery and soap, where condensation may result in mould growth. In such instances it is often preferable to allow a controlled rate of moisture uptake, and thus allow the package to 'breathe', rather than trap the moisture inside by using a highly impermeable barrier.

Grease resistance may be measured by the turpentine test or the oleic acid test but in both instances it is difficult to correlate the results with the behaviour in practice. It is therefore preferable to carry out tests using the actual commodity to be packed in the material, if necessary by storage at elevated temperatures to accelerate the results. For example, in assessing the resistance of material to be used for packing biscuits, the results of a turpentine test have very little meaning, and it is essential to carry out tests with the actual biscuits.

Gas resistance can be measured by several methods, but the interpretation of the results entails difficulties similar to those for W.V.P. results. It is therefore necessary to carry out storage trials on the complete pack in order to predetermine the gas resistance required of the material.

Tests on materials include the chemical tests, such as the determination of pH, free chloride or sulphate, and reducible sulphur. The methods of testing are fairly standard and for packaging commodities, which are likely to be affected by such agencies, the safe limits are usually specified, or are well known. The more important of these are probably the safe limits for pH, chlorides and sulphates, for materials used in contact with ferrous metals. The usual limits are:

pH 5·0 - 8·0

Chlorides less than 0·05 per cent as NaCl.

Sulphates less than 0·1 per cent as Na_2SO_4.

In addition, for materials used for packaging silverware the amount of reducible sulphur should not exceed 2 p.p.m.

Testing of Packages

Under this heading the tests are carried out on the complete pack and the results can therefore be used to assess the efficiency of the package under practical conditions. The main difficulty with this type of test is in reproducing practical conditions in the laboratory, but despite these difficulties the results are of great value and comparative tests between packages can show quite definitely the advantage of one type of pack over another. If, of course, a standard pack is available which has a known performance due to its use over a period of time, it can be used as a yard stick in correlating the test conditions with the conditions occurring in practice.

These tests can again be split into those concerned with the protection against atmospheric hazards (e.g. water and water vapour) and those concerned with the mechanical hazards.

The resistance of a package to water can readily be assessed by a simple 'shower' test, preferably carried out after suitable rough handling.

The resistance of a package to water vapour, which may be either water vapour uptake or loss depending on the commodity, can readily be measured by storage

under suitable conditions together with weighing at regular intervals. By this method, the rate of water uptake or loss can be determined accurately. This may be used either for direct comparison with an alternative pack under the same conditions or, if necessary, the actual 'shelf-life' of the pack, under particular conditions, can be estimated. In the latter case the initial and critical moisture contents must be known, the initial moisture content being that at which the product is packed and the critical moisture content that at which the product becomes unsaleable.

If necessary, the efficiency of the closure and the effect of creasing can be measured by blocking out the closure or the creases and redetermining the rate of uptake or loss. In addition it is usually advisable to carry out measurements on packages which have been subjected to the mechanical hazards of a journey, by suitable laboratory tests.

In instances where it is not possible to assess the resistance of the package by actual changes in weight, the only method available is to carry out large scale storage trials. If it is possible to open and reseal the pack without detriment, periodic inspection will reveal any deterioration and the efficiency of the pack can be assessed by visual examination, or tests on the contents. Comparisons with alternative packs can also be made. For packages which are not easily resealed it is necessary to store a number of packages and to remove samples at intervals for inspection. If necessary the storage can be accelerated by using more severe conditions, or by alternating the conditions to give cycles of heating and cooling with corresponding changes in humidity. The acceleration, under such circumstances, can of course only be estimated approximately, but comparative tests are quite simple to carry out.

Under this heading the odour of packaging materials and its possible transfer to the contents to produce tainting may be included. The package may possess an odour either due to the material itself or to additives, such as wax, coating material, printing ink, etc. Slight odours can usually be detected after the material has been stored in an enclosed space, such as a glass jar, for a number of hours and the odour usually becomes more noticeable under damp conditions.

For identification of the source of the odour, the most satisfactory method found so far is the 'fatigue' technique. An observer smells a suspected sample. He is then fatigued, by prolonged smelling, to a particular odour, which may be the paper, board, printing ink, or printing ink constituent. He is then asked to smell the suspected sample again and if the particular constituent is the cause of the odour, the smell of the suspected sample cannot be detected. This method can be difficult to apply, if the odour is due to a number of different sources, but it does have the advantage that it is independent of personal preferences and opinions, the observer only being asked whether there is any odour or not, without any attempt being made to classify the odour. The observations of a number of people can, in many instances, be found to point quite definitely to a particular constituent as the source of the odour.

In the packaging of foodstuffs, the packaging material can transfer an unpleasant flavour to the foodstuff. The possibility or cause of such transfer can be ascertained by storage of the particular foodstuff with the suspected material in a glass jar, for a period of about 24 hours. A number of observers are then asked to taste the tested specimens, together with two controls which are fresh samples of the foodstuff, and to pick out the one which is different. This method again avoids any personal preference as the observer is merely detecting a difference, or otherwise, between three samples.

The mechanical tests are designed to assess the resistance of a package to rough handling during transport. The normal hazards may be classified as drops, shunting shocks, stacking and vibration, and the laboratory tests are designed to reproduce these types of hazards. The equipment generally used is as follows:

1. *Drop Tester.*—The normal drop tester consists of a simple hoist equipped with a sling for holding the package in any desired position. The hoist is fitted with a quick-release mechanism for causing the package to drop, when it has been lifted to the required height.

For packages which are difficult to hold with a sling, a quick-release trap-door is available, on which the package is held or rested. The trap-door is opened quickly and caught in the open position, in order to allow the package to fall freely.

2. *Drum Tester.*—The drum tester is designed to carry out the drops automatically. It consists of a hexagonal drum fitted with baffles on each of the six faces, in which the package is caught up, as the drum rotates. These machines are normally made with a diameter of either 7 ft. or 14 ft. The disadvantage of this test is that the conditions are not strictly reproducible, and will vary for each package depending on its size and shape, etc.

3. *Inclined Plane Tester.*—This machine is designed to reproduce shunting shocks and consists of a track, inclined at an angle of ten degrees to the horizontal, on which runs a 'dolly'. At the bottom of the track is a bumper, fitted at right angles to the track. The package is placed on the dolly, which is then hauled up the track to the required height and allowed to run down and crash into the bumper. The required height being chosen to give the necessary impact velocity at the bottom, the normal velocities being 4 to 4½ m.p.h. for home trade and 6 to 7 m.p.h. for export.

4. *Compression Tester.*—This instrument measures the safe stacking height, when packages are stored. It consists of two parallel plates between which the pack is compressed, the load being measured on a dial or recorded automatically. It is capable of applying loads up to 10,000 lb. and may be used either with a full or empty container. Its main use is in testing fibreboard

cases, the failure load being used to calculate the safe stacking height under given conditions. Usually the safe stacking load is calculated by multiplying the failure load by a factor of one-third to allow for a safety factor and stacking for prolonged periods.

5. *Vibration Tester.*—Several types of vibration tester are used but one of the more common is the L.A.B. tester. This consists of a table, which is made to vibrate with an amplitude of one inch, at speeds varying between 180 and 360 v.p.m. Its purpose is to assess the resistance of a package to the vibration hazards entailed in journeys by road and rail.

In many instances, vibration can be the most important hazard and testing for only half an hour can reveal any weakness in this direction, e.g. loosening of the nails in a wooden case made from badly seasoned timber, breaking of fragile articles by resonance, squashing of soft articles such as cakes and the rubbing of printed surfaces.

Despite the difficulties of reproducing practical conditions in the laboratory, a great deal of information can be obtained, both in revealing any weaknesses of a package, which may not at first be apparent, and also in comparing alternative packs under identical conditions. A practical transport trial is obviously the only absolute means of assessing a package, but such a test is very costly owing to the need for carrying out the test over a sufficiently long period to overcome the variation in handling and the large number of packages required. Alternatively the test must be planned statistically and the results carefully analysed. This point is illustrated by the results of a transport trial in which a number of P.A.T.R.A. journey shock recorders were included in the consignment. The P.A.T.R.A. journey shock recorder consists of a counter which is pre-set to record all drops above a certain height, a 'battery' of about 20 being fitted in each case. The recorders were fitted in 20 identical cases and sent on identical journeys, from London to Manchester. The cases were despatched in batches of four, at intervals, by mixed goods rail transport.

The results showed variation as follows:

18 drops of 3 to 6 in.
1 drop of 6 to 12 in.
5 drops of over 12 in.

1 drop of 3 to 6 in.
2 drops of 6 to 12 in.
No drops over 12 in.

The other 18 cases showed results distributed evenly between these two limits. Unless, therefore, the results of a transport trial are very carefully analysed it is quite probable that they are merely demonstrating a variation in handling rather than any property of the package. Results on similar cases for a full container rail journey showed a much lower degree of rough handling and also less variation, the largest number of drops recorded on any case being four drops from 3 to 6 in. and four drops from 6 to 12 in., thus adequately demonstrating the necessity for considering the package and the test with reference to the particular type of transport to be used.

When testing packs containing a number of items, such as tins, bottles or jars, the damage can be assessed by counting the number of dented tins or broken jars and in such tests the reproducibility of the results can be demonstrated. A fibreboard case containing 48 tins might be found to contain 15 badly dented tins on completion of the tests; an identical pack subjected to the same test sequence would be found to duplicate this result, with a variation of approximately $\pm$ 2. If, therefore, an alternative pack can be found, which gives a result of 5 $\pm$ 2, the superiority of such a pack can be proved. If necessary, the two packs may be tested over a sufficiently wide range of drop heights to cover all possible contingencies.

In designing suitable laboratory tests the size, weight and shape of the package must be considered in addition to the destination and the type of transport involved. The types of test may be considered under three headings:

Assessment
Comparison
Investigation.

Assessment testing may entail a detailed study of the particular journey as a basis of reproducing the hazards in quality and number. Alternatively the type of sequence used for comparative testing may be applied. This is designed to reproduce an equivalent level of rough handling rather than the exact number and height of drops, etc. The investigation type of testing is designed to show up any weakness in the package and usually entails applying most of the test methods, in which case a drop test would be designed to cover all positions of fall.

The normal sequence of tests is designed to subject the pack to blows in every possible direction and if the pack is symmetrical this entails impacts in the following positions:

(*a*) Base
(*b*) Long base edge
(*c*) Short base edge
(*d*) Base corner
(*e*) Side face
(*f*) End face
(*g*) Vertical edge.

For packs which are unsymmetrical from top to bottom, such as packs containing bottles or jars, a second sequence is necessary using the top as the base. Alternatively, for packs which are completely unsymmetrical, e.g. containing machinery, additional drops may be necessary on to the other faces, edges and corners. If the shape of the case is such that one of the vertical faces is larger than any other, it may be necessary to carry out the sequence using this face as the base.

Of the above impacts, (*a*), (*b*), (*c*), and (*d*) are usually carried out by dropping and (*e*), (*f*), and (*g*) by blows on the inclined plane tester, an additional drop on to

the top of the pack being included after (*d*), and the five drops being repeated from a greater height after the inclined plane test. A common sequence used for home transport thus takes the following form:

Five drops as follows: Base
Long base edge
Short base edge
Base corner
Top

Blows on each side, face and vertical edge on the inclined plane tester are followed by five drops as above from an increased height. Additional drops are carried out on the other faces and edges if the pack is not symmetrical.

In carrying out the edge and corner drops, the package is arranged so that the diagonally opposite edge or corner is vertically above the point of impact. This usually means that the centre of gravity of the pack is also directly above the point of impact, and this method is chosen purely for convenience in arranging the pack, the purpose of the test being to reproduce the degree of rough handling, which is likely to occur in transit, and not the exact nature of the drops, which in practice will be somewhere between the face, edge and corner drops used in the test.

The side blows, to which the package is subjected on the inclined plane tester, can be satisfactorily replaced by drops on to the same points in most instances. The normal type of sequence thus becomes as follows:

(*a*) Base corner
(*b*) Adjacent long base edge
(*c*) Adjacent short base edge
(*d*) Adjacent vertical edge
(*e*) Adjacent large face (base)
(*f*) Adjacent medium face (side)
(*g*) Adjacent small face (end).

This seven-drop sequence thus consists of drops on to a base corner and each face and edge radiating from that corner; with suitable additional drops being made in instances of asymmetry. The substitution of drops for blows on the inclined plane tester, may not be satisfactory in some instances, such as packages containing soft cushioning material, where the fact that the cushioning material is supporting the weight of the contents, before the impact, may affect the results. In the majority of instances, however, the resulting damage is the same.

The drop heights required for these tests will depend on weight and size of the package, possibly modified due to any special facilities or difficulties in handling, and also the destination and type of transport. For home trade packages between the approximate weights of 35 to 100 lb. travelling by mixed goods journey, road or rail, the drop tests are normally carried out at 1 ft. and 2 ft. drop heights. For loads below the 30 lb. limit the package is quite likely to be thrown, and the sequence may need to include 3 ft. and 4 ft. drops. Loads above 100 lb. are normally a two man load and drops will be progressively lower until mechanical handling is required, always with the possibility that the case may be rolled over, or slid or dropped from the tailboard of a lorry. Packages despatched in full container loads or by direct private transport, will be handled much better and drop heights can be reduced. Export packs are normally tested by using the same sequence but the drop heights increased by 6 in or 12 in.

If a standard package is available, the performance of which is known due to its use over a sufficiently long period of time, the result of subjecting it to the suggested test sequence can be used to assess the accuracy of the reproduction.

It is not possible to lay down rigid test sequences or even rules for the design of suitable laboratory tests and each package must therefore be considered as a separate problem.

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Allen, R. T. L. and Paine, F. A. (1951). Journal of the Science of Food and Agriculture, May.

Forthcoming Congresses

ILMAC, the International Exhibition of Laboratory, Measurement and Automatic Control in Chemistry and two congresses in connection therewith, will be taking place in Basle, the centre of the Swiss Chemical Industry, from November 10 to 15, 1959. The technical congresses are organized by the Association of Swiss Chemists and the Swiss Federation of Automatic Control, and are at the same time the 22nd Meeting of the European Federation of Chemical Engineering. The technical exhibition is being organized through the agency of the Swiss Industries Fair.

Thirty main lectures have been planned and among the speakers are well-known representatives of theoretical and applied science from Belgium, Germany, France, Holland, the U.S.A. and Switzerland. In addition to the actual programme, many lectures and demonstrations are being arranged by the firms participating in the exhibition.

The Congress on Laboratory and Measurement to be organized by the Association of Swiss Chemists on November 10 and 11 is strictly confined to the field of chemistry. One half-day will be devoted to the discussion of each of the following: electrical methods, optical methods, separation methods and isotopic methods.

The programme of the Congress of the Swiss Federation of Automatic Control which takes place on the two following days is somewhat broader in its scope. The lectures and discussions on the first day are devoted to technical questions of automation in process engineering in the chemical and food industries, the second day has the economic aspects of automation as its theme, and the third day is reserved for data processing in economics. Single lectures can be heard on the use of data processing machines in the chemical industry, in banking, administration and in public utilities, in production planning and in solving major problems.

The specialized Exhibition of Laboratory, Measurement and Automatic Control in Chemistry which is being held at the same time as the Congresses in the halls of the Swiss Industries Fair, is the first of its kind in this field to be held in Switzerland and great interest has been displayed by manufacturing and technical trading concerns.

The fact that the exhibition has been confined to an extremely limited field which is nevertheless of considerable importance, affords potential customers—not only the larger concerns but all those smaller enterprises possessing their own laboratories—the possibility of comparing all those products of interest offered on the international market.

TECHNICAL WRITING

by E. H. W. Banner, T.D., M.Sc., F.Inst.P.

This article is intended to discuss some of the finer points in the wide scope of putting knowledge on record by writing or printing. Many technologists and others are excellent in the practice of their particular work, but are quite unable to present it well as instruction, either verbally, which is generally easier as it cannot be readily checked afterwards or in writing for publication, where it may persist and be used in evidence against them.

Write for the Reader

It should be accepted as an axiom that the whole purpose of writing, with or without any short-cuts, is to present the subject to the reader in such a way that it will readily be assimilated and be without ambiguity. Drawings sometimes contain contractions which help the drawing office to produce the drawing with minimum effort and cost, but if these contractions mislead the reader then they are not justified, even if they do save money in production. Similarly a well-written article is more likely to be read fully than one that makes the reader puzzle over what is meant, or worse still gives him a false impression.

This generalization excepts the many wordy legal documents that on occasion have to be read, and possibly with that knowledge in mind the writer seems to take a delight in making the meaning as obscure as possible —at least that is the popular impression. However, it is true that in order to be free from ambiguity some extra wording and cross-referencing may be necessary.

Some common phrases used in everyday speech are well-known and permissible, but when in black and white are seen to be misleading and so to be avoided. A common term in everyday language is 'just about'. This is permissible in conversation, but it should have no place in scientific and technical literature. The two words contradict: 'just' implies precision and 'about' implies uncertainty.

It is doubtful whether the spoken or the written word can best convey an unambiguous message. Whereas the spoken word can give many special inflections or emphasis where needed, in print it may be necessary to adopt very elaborate and difficult to read underlining and extra punctuation. For example, a given sentence might be spoken either as a statement or as a question, depending entirely on the vocal inflection. On the other hand, the written word can differentiate in many ways, such as by the use of 'quotes', capitals large and small, bold-face letters etc., to indicate if a special or a general case is being considered, with correct punctuation, layout, etc. Similarly a difference of words with the same pronunciation but different spelling can only be made unambiguous in print or type.

Terminology

Terminology, as with symbols, is well laid down in various B.S.I. Glossaries*. Many people unfortunately use old terms either because they are unaware of the correct term or because they are so individual that they prefer to use the old term and leave the listener or reader the job of translating to obtain the meaning intended.

A good example of rationalization in terminology occurs in the term 'condenser'. This has applications in optics, physical chemistry and probably other branches of science. It has long been abandoned in standard electrical terminology, partly to avoid the other usages, and in order to line-up with the comparable terms of 'resistor', 'inductor', etc.; the term 'capacitor' is now used in the electrical sense. Although this term is in common use it is not universally known, and one electric motor manufacturer refers to the firm's capacitor motors as having condensers with them!

Symbols

It is fortunate that in many branches of technology there are definite standards of approved symbols; it is not just left to what a user may consider common practice but which on occasions may be only his own practice. The correct use of symbols can help to contract an article appreciably, and when the script is limited to one side of a given sheet, a card in a card index, etc., such a contraction can be most valuable. But symbols should only be used when it can reasonably be expected that the average reader will understand them without trouble or the possibility of a wrong meaning. Thus a speed of 30 m.p.h. or a current of 15 A may justifiably be used in most places, but 'megawatts' is best printed in full in a non-technical publication such as a newspaper, avoiding the absurd case of a printer showing it as 'mW', which is by no means unknown. The use of symbols for feet and inches on a drawing is common, but the same symbols used in an article to be reproduced in say a ladies' paper may not be justified.

Many users of symbols are unaware of a cardinal point in their use: that the symbol covers both singular and plural. The term '15 mAs' is sometimes wrongly used for fifteen milliamperes, but it means 15 milliampere-seconds, and it is so used in x-ray engineering. A very bad example of this was seen in an advertisement in a leading electrical journal, where 'kV's' was boldly displayed. It is possible that the originator wrote it correctly and it was altered by the printer, but in any case it should have been checked to eliminate such an example which does harm to a firm's reputation.

*Some relevant British Standard Glossaries are given at the end.

The use of wrong symbols is to some extent understandable when the writer cannot forget what he learned many years before. But when a young student uses wrong symbols because he has been taught that way recently, then the primary fault is with the teacher and the teaching institution which allows wrong symbols to be taught. It is unfortunate that some physics teachers appear to have no idea that standard terminology and symbols exist, or alternatively think that as physicists they need not conform to engineering practice.

Abbreviations

Many technical terms are abbreviated in print, to some extent as an intermediate stage between the full words and the shorter symbols. Again there are standard forms in many cases, and they may well be used with discretion in even non-technical publications.

There are two schools of practice with regard to the ending of abbreviated words: the older is to add a full stop or point at the end of each abbreviated word, as Mr., ft., in., etc., but the more modern way is to use a full stop only where the last letter is omitted, excluding it from words where the omitted letters are in the middle; thus Mr as the last letter is retained, but res. for resistance, as the final letter is dropped. Apart from consistency in any one publication editors or 'house rules' are the best guides.

The use of non-standard abbreviations such as 'mfd' or 'mFd' for microfarads has nothing to commend it. If the reader understands symbols then the correct 'μF' should be used, but if not, as in the case of a non-technical storeman, a clerk, etc., then it is always best to keep to the word in full. In a somewhat similar way the use of letters on the telephone can give a false impression on occasions, such as '10 M.A.' given in letters. This may be written down as mA for milliamp or μA for microamp, but it is most unlikely that it is meant for megamp, which is the meaning of '10 MA'.

Spelling, Punctuation, etc.

Sometimes alternative spellings are used correctly and the criterion is really dependent on which dictionary the writer or editor uses. Thus 'connexion' is the preferred way in the Oxford set of dictionaries, but many others spell it 'connection'. Both spellings are therefore correct, but it is necessary to keep to one spelling and dictionary throughout a given publication.

Modern printing tends to omit unnecessary full stops, such as at the ends of titles, captions, etc., and this has much to commend it, although to some extent personal preference comes in. Perusal of a modern book or handbill compared with a similar sort of publication 50 years ago will show this well. It can be overdone, of course, as OHMS may mean a resistance in ohms or the official meaning. The converse of cutting out stops is seen in the bad examples of some hand-written signs in shops, on placards and the like, where every word is followed by a full stop.

In some publications the decimal point is wrongly printed as a lower stop instead of a middle point or or stop, as 3.4. In other instances, especially in mathematical work, a lower point is used as a multiplying sign, as 3.4. The possibility of confusion can be readily seen. A practical point here is that with an ordinary typewriter it is usually possible to type a correct middle point by partially depressing the shift key while typing a normal point or full stop. This cannot be done on electric typewriters, where the shift key must be either fully up or down.

Where literal quotations are made the common school teaching is that double quotes are used first, with single quotes for expressions inside the double quotes. While this is still correct, the alternative way of single quotes first is equally authentic: it is that used in the Oxford set of dictionaries, for example. The essential point is again to choose one way and keep to it throughout any one publication.

English practice is for an adjective to precede its noun. For catalogue and kindred purposes it is common to classify under the initial letter of the noun, followed by any qualifying adjective. Thus a 'testing instrument' may be catalogued under 'I' as 'Instrument, testing'. But it is fairly common in some quarters to use this form for normal use, describing the particular apparatus as an 'Instrument testing', and without the comma to separate the noun from the adjective. The practice is much to be deplored. This example is often followed by the Services, although official regulations for certain publications instruct against this.

The apostrophe s is being increasingly used as a plural form, such as TEA'S, and this is not unknown in technical publications. There is in some cases no clear lead, it is true, and in the expression 'the letter T's are too big' the apostrophe seems to be justified. Where e.m.f.'s is preferred it can instead be shown as e.m.f.s, and fortunately for purely technical symbols this does not arise as the plural form is the same as the singular.

Hyphens could be used more often than they are in order to avoid ambiguity. In general the hyphen is a joining symbol and the oblique stroke a separating sign. For example the range of 4 to 8 may be shown as 4 - 8, while the stroke well separates 24/11/59, as in a date, or AB/CD as in a reference, etc. For technical work the stroke should not be used where a product is meant, as ft.-lb. and not ft./lb. Although this may look obviously wrong it is sometimes seen in print. In this actual example B.S. 205 gives ft.lb. for this quantity. There is a tendency in some newspapers to print a hyphen where a stroke is correct; the reverse of the point made above. An example is in 5 7-8 for 5 7/8 or five and seven-eighths.

APPENDIX

Some relevant British Standards of interest.

B.S. 1991: Letter symbols, Abbreviations and Signs of common interest in Physics, Chemistry and Engineering.
2474: Recommended names for Chemicals used in Industry.
1611: Glossary of Colour terms used in Science and Industry.
1523: Glossary of terms used in Automatic Controlling and Regulating Systems.
205: Glossary of terms used in Electrical Engineering.
204: Glossary of terms used in Telecommunications.
233: Glossary of terms used in Illumination and Photometry.
2597: Glossary of terms used in Radiology.

An Apparatus for Perfusing Nerve Fibres

by J. P. Heslop, M.Sc.

Pest Infestation Laboratory, Slough, Bucks.

DURING investigations of the rates of transport of cations across cockroach nerve membranes an apparatus was built for perfusing short lengths of abdominal nerve cord or single ganglia *in situ* with saline solutions. After it had passed over the nerve the perfusing fluid had to be collected uncontaminated by blood or other foreign matter. As valid experiments are impossible when unprotected nerve fibres are exposed to the air, all perfusions had to be carried out with the preparation immersed in Ringer solution.

A general view of the apparatus and a diagrammatic cross section of it are shown in Figs. 1 and 2. The experimental animal is fixed with adhesive tape to a bed of paraffin wax in a square brass tank. Due to its weight and the flatness of its base the tank can slide smoothly over the greased brass table so that the position of the animal can be altered relative to the perfuser. A locking bar enables the tank to be clamped to the table and is so arranged that the whole tank assembly can be removed from the table by turning it through 90°. The perfuser can also be readily detached from the table.

The perfuser itself is made of stainless steel. Basically it consists of a slotted supporting bar carrying a 1·75 mm. O.D. tube of 1·0 mm. bore; 13 mm. from the tip of this tube is a V-shaped notch of 90° included angle. When the nerve being studied is lying across the notch the gap above it is blocked by a steel wedge which does not obstruct the lumen of the tube. Fig. 3 shows a ganglion in position. The holes left on each side of the tube for the nerve to pass through, and the gap between the wedge and the perfuser tube, are sealed with soft white vaseline. Great care is needed when applying the vaseline to ensure a good seal without allowing any grease to spread on to the part of the nerve being examined. Silicone greases are unsuitable owing to their low mechanical strength and tendency to spread. Rubber-based greases are to be avoided because they seem to interfere with conduction of the nerve. With a little practice a satisfactory seal can be assured.

The wedge is firmly fixed in position by a spring-loaded plunger which pulls upwards upon the end of the rocker arm. This arm passes through a slot in the supporting bar which prevents lateral movement. All of these parts were accurately machined and there is virtually no 'play' between them.

When in use a stream of insect Ringer solution (Hoyle, 1953) is passed at the rate of 0·2 ml. per minute through the perfusion tube and allowed to drip from the outflow into a collecting vessel. The formation of drops causes the pressure to fluctuate, rising as a drop starts to form and falling as it gets heavier. In practice grease seals stand up much better to fluctuating pressures of this type than to steady pressures, however low. On testing such seals by perfusing with strong eosin solutions no leakage of the dye into the tank could be detected. Similarly no leakage inwards was found when the eosin solution was placed in the tank

Fig. 1. General view of the apparatus. The bath fluid, reservoir, and collecting vessel have been omitted.

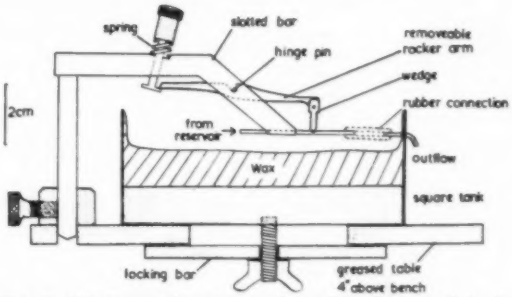

Fig. 2. Diagrammatic cross-section of perfuser and bath assembly.

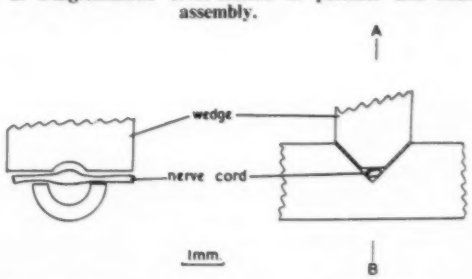

Fig. 3. Detail of perfuser notch showing a ganglion in position.

and distilled water used as the perfusing fluid. The rubber tubes connecting the perfuser to the reservoir and the outflow tube make good joints on to the stainless steel tubes. Fresh rubber tubes are used for each experiment.

This apparatus was designed to show whether the rates of efflux of radioactive sodium and potassium ions across insect nerve membranes were altered by insecticidal action. Before insect nerves can be studied in this way the connective tissue sheath investing them must be removed (Twarog and Roeder, 1956). The mechanical strength of desheathed fibres is too low to permit manipulation on to the perfuser and this operation must be performed with the nerve cord in position. Absolute efflux values in terms of weight/unit membrane area/unit time cannot be determined using nerve trunks containing numerous fibres of widely different diameters. The slopes of the graphs of $\log_{10}$ concentration in each sample against time of sample give reproducible estimates of the rate of efflux, however, and changes in slope can readily be detected.

It is necessary to make experimental correction for adsorption on the perfuser and collecting tubes. The total adsorption can be greatly reduced by coating the apparatus with a film of silicone. The residual film remaining after the apparatus has been wetted with silicone oil or a suspension of silicone grease in petroleum ether and washed 'clean' with organic solvents is adequate.

This apparatus may be of use in investigations of rates of efflux from nerves, blood vessels and other structures in small animals provided the structure under examination does not move. It is not suitable for making accurate determinations of influx rates.

ACKNOWLEDGMENTS.—*It is a pleasure to acknowledge the help of Mr. Cordaroy who built this apparatus in the laboratory workshop and improved on many details of the prototype. This paper is published by permission of the Department of Scientific and Industrial Research.*

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An Electric Shocking Device as a Laboratory Aid to Fish Studies

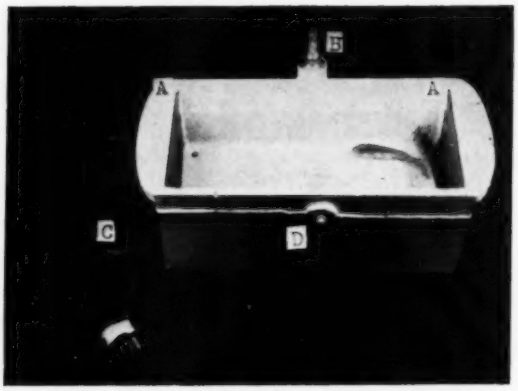
by G. R. Fish

Fish Culture Research Station, Malacca, Malaya

MANY of the techniques used in fisheries research involve the killing or narcotizing of specimens. Frequently, a sharp blow on the head is regarded as sufficiently lethal. Many species, however, have well developed muscles near the base of the skull which render this method of killing ineffective if extensive damage to the animal must be avoided. In particular, when small specimens are to be examined, considerable damage nearly always results from such a method of killing. In any case, some damage to the specimen is inevitable, however skilful or experienced the operator may be.

The apparatus shown in Fig. 1 has been found of value for killing or narcotizing fish. Several models have been constructed but the one figured has proved to be the most convenient. It consists essentially of a well-jointed wooden trough, $18 \times 12 \times 12$ in. Following the recommendation of the research department of a large paint manufacturer, the box was painted inside and out with two coats of a white PAR paint, 'Paralux II'. This is a quick drying alkyd resin paint and it has proved satisfactory in rendering the trough completely watertight. The two electrodes are made of brass gauze and cut so as to fit easily into the opposite ends of the box. These electrodes are connected, through a switch, to a 230 volt mains supply. A warning lamp (230 volts, 5 watts), which lights when the current is passed, is connected in parallel across the electrodes. A polythene tube, by means of which the tank is filled and emptied, is connected to a small hole pierced in the bottom.

The above arrangement passes a current of 0·25 amp. at 230 volts when using water with a conductivity up to



The chief components of the tank are as follows: (A) Brass gauze electrodes, (B) Warning lamp, (C) Tube for filling and emptying, (D) Press button switch.

200 'Dionic' units. The current increases as the salinity of the water rises. Esturine water salinity 0·7‰ takes a current of 2·0 amp. and when using water of higher salinity it becomes necessary to introduce extra resistance into the circuit. By such means, the apparatus has occasionally been used with animals in sea water. On the whole, though, it has been found in this laboratory that the apparatus can rarely be conveniently employed with waters having a salinity above 1‰. However, satisfactory results have been obtained using low salinity water and adding the marine specimens immediately prior to operating the switch.

When in use, the trough is filled to a convenient depth, the fish added and, if necessary, left in darkness to recover from the shock of transfer. The button is then pressed and the fish are immediately stunned by the current. Death ensues if the fish are exposed to the current for a sufficient length of time. This rarely exceeds more than a few seconds, depending upon the specimen size and species and the electrical resistance of the water.

The susceptibility of the various fish species to an electric shock of this nature is somewhat variable. During the course of many investigations here, it has been noticed that the Climbing Perch (Anabas) and the Chocolate gourami (Colisa) are very susceptible. Tilapia species are the most resistant with Sepat (Trichogaster) and Siamese Fighting Fish (Betta) being intermediate in their reaction.

If the fish in the trough are subjected to the electric current for only a short time, they are stunned but recover afterwards and apparently suffer no ill effects. A similar observation has been made by Meyer-Waarden (1957). This effect often finds convenient application when fish have to be examined or treated but not killed. For example, during the process of sexing young *Tilapia* for purposes of monosex culture, each fish must be caught and examined. As they often struggle vigorously, the operator is forced to hold them firmly. The shock of capture and often of pressure causes damage which may result in a subsequent mortality of these young fish. Such mortality has been known to be as high as 50 per cent or more. If the fish are first lightly stunned in the above apparatus, they can be handled without difficulty. They recover completely within a few minutes of being returned to the water and no mortality ensues. The attachment of identification marks to a vigorously struggling fish is often difficult and inaccurate. Depending on the type of mark used, it may lead to undue skin laceration and wounding of the fish. It has been found here that such work is greatly facilitated if the fish are electrically stunned before marking. The operator then has the opportunity of inserting and securing the mark with accuracy and care. The above procedure has also been adopted in order to reduce damage and shock to the specimen when experiments require sampling of stomach contents, forced feeding, hypodermic injection or similar minor operations.

The apparatus has been found of value in this laboratory as a method both for killing and for rapid narcosis. The main advantages are that, in action, it can cause death or narcosis rapidly and neatly, with a minimum of damage to the specimens. It is cheap and simple to make. In addition, it is light, portable and easily modified to suit particular conditions.

I am grateful to the Director, Fish Culture Research Station, for information regarding *Tilapia* mortality during sexing, and to Messrs. Sime, Darby & Co., Ltd., for specialist advice and for a sample of 'Paralux II' paint.

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Meyer-Waarden, P. F. (1957). 'Electric Fishing.' F.A.O., Fish Study No. 7.

BOOK REVIEWS

Semiconductors, edited by N. B. Hannay. New York: Reinhold Publishing Corporation. London: Chapman and Hall Ltd. 1959. 120s. pp. 767 + xxiii.

In the past the subject of this book has undoubtedly been considered to be of primary interest to the physicist. Rectifiers, photocells and transistors are of course to him very important tools and one has tended to forget the background chemistry of the semiconductor. A grand total of 17 authors have very ably redressed this matter by their contributions here, and have shown how the theory and practice of chemistry were essential before the semiconductor could attain the important position it holds today.

As one reads this book, the remarkable fact becomes obvious that the subject makes use of practically every aspect of physical chemistry. Thus in the first chapter quantum theory provides the concept of valence and conduction bands, the transfer of electrons from one to the other by heat or light, being one means of producing semiconduction. The same theory is much used in later chapters to explain the optical properties of these materials. Since one is much concerned with the behaviour of the individual atom of impurity, kinetic theory is called in. Chemical thermodynamics can treat the crystal imperfections such as vacant sites, impurity atoms, conduction electrons and holes, even when intangible, as solutes in the solvent crystal lattice. Statistics help the determination of the state of occupancy of the various electronic states in the semiconductor. Besides these main aspects, surface chemistry for the junction, diffusion and partition coefficients for crystal growth and the physical chemistry of all possible states of matter are used in this book.

It must not be supposed from the above that the treatment of the subject is only mathematical. Very complete practical details are given in an excellent chapter on crystal growth. Inorganic chemistry has by now provided many more examples of semiconductors

than the well-known silicon and germanium, and appropriate chapters treat of these other elements and their compounds. Of particular interest is the use made of the covalent bond in explaining the properties of some inorganic semiconductors, its confinement to the common elements of organic chemistry having now disappeared for ever. However, some organic semiconductors are known (there is a chapter dealing with these) many of them being condensed aromatic hydrocarbons. One may well appreciate the extra difficulties of purification inevitable when dealing with organic compounds and the need to be sure that one is not measuring ionic conduction.

This is a book to be recommended to anyone interested in the subject and to anyone interested in a better appreciation of the links between all branches of chemistry. It might be supposed that continuity is lost in a book of this type with its abundance of authors. This is not so, for it is clear that each one had a full appreciation of the complete work and such duplication as does occur is small.—A. S. FREEBORN.

Electronic Apparatus for Biological Research, edited by P. E. K. Donaldson, M.A. 1958. London: Butterworths Scientific Publications. 120s. U.S.A.: Academic Press Inc., $20. pp. 718 + xii.

Donaldson has produced this valuable technical handbook from long practical experience and in particular during the last five years from his association with the Physiological Laboratory, Cambridge. A handbook of 730 pages is scarcely a handbook in the literal sense of the word and yet every page is crammed with useful information and large as it is, it is barely big enough to do justice to the various ramifications of the subject. The author has called to his assistance six other contributors: this makes the book authoritative over a wide range of subjects. The emphasis is upon electronic techniques rather than detailed descriptions of individual pieces of apparatus and, as the author points out, the main difference between apparatus used by workers in widely different fields lies often less in the electronic gear proper than in the transducing devices used, that is on the devices that link the electronic circuits with the remainder of the experimental set up.

The book is divided into four parts. The first part (280 pages) deals exhaustively with the theory underlying the use of resistance capacitance inductance, hard and soft valves, negative feed-back and cathode follower circuits. Only elementary algebra and the simplest ideas from the calculus are involved.

Part II (50 pages) deals with the more practical aspects of components: batteries, resistors, capacitors, chokes, transformers, diodes, valves, tools and workshop facilities. It is unfortunate that discharge curves are not given for batteries, particularly the nickel iron type. By error the nickel hydroxide plates of the NIFE batteries are called negative.

Part III (248 pages) deals with transducers, electrodes and indicators. The first section on light sources and photo detectors is excellent as it brings together information which is otherwise difficult to find in any one book. It is a pity in this section that glass, gelatin and other types of colour filters are not dealt with, and that only Corning heat filters are mentioned when equivalent filters are available from Chance in this country. In a table giving details of filters for isolating mercury lines, the 365 mμ is isolated by Wratten 18A or Ilford 806; a better Ilford filter is Ilford 828 and in fact both Wratten 18A and Ilford 828 are Chance Woods glass filter OX1. In the next section, on temperature measurement and control, the word 'coolth' appears. Another example of strange English is 'lossy' when dealing with losses in capacitors. Geiger and scintillation counters are dealt with in a small section about assay of radioactivity. A description of visual indicators such as meters, magic eye null point indicators and cathode ray tubes precedes an excellent section on transducers for various applications, such as limited movement or continuous rotation, mechano-electrical or electromechanical in each case. This part ends with sections on relays and related mechanisms, microcapillary electrodes for potential measurement in living tissue.

Part IV (126 pages) deals with complete apparatus and in this as in many other parts of the book the editor's first-hand experience allows him to give the reader much useful information to avoid pitfalls, difficulties in the design of amplifiers being particularly well dealt with. Transistors are dealt with in the last 24 pages of this part and there is no doubt that the rapid advance taking place in this field will soon make some parts of this book out-of-date. Despite this possibility it is invaluable to any research worker in the biological field.—S. Y. THOMPSON.

A Handbook of Colorimetric Chemical Analytical Methods, 5th Edition. Salisbury: Tintometer Ltd. 1959. 30s. plus postage 2s. (unpaginated).

Permanent colour standards for colour measurements have for long been accepted for routine analysis and control in industry. This large loose-leaf volume is an annotated catalogue of all the Tintometer discs issued to date, and it automatically serves as a very useful handbook on the subject. There is today a Tintometer disc for almost every colorimetric test of any importance. The 360 pages of this new edition are grouped in seven parts: the Lovibond apparatus, pH, inorganic, organic, medical, noxious vapours, and colour and quality grading tests. Each purchaser is entitled to new pages for two years as they are issued, and this is the reason for non-pagination.

Each item is written according to the standard Tintometer pattern: introduction, principle of method, reagents, disc, technique, notes and references. In these days of multiplicity of publications the conciseness of writing will be appreciated. Any chemist can acquire the essential knowledge about any of these tests in a few minutes. With some items only rather dated references are given; presumably this is because references are

restricted to the original papers describing or commenting on the method employing a Tintometer disc.

The absence of pagination makes an ordinary index impossible, but as the items in each part are listed alphabetically, and a complete list of subjects and equipment required is given at the beginning of each part, it is quite easy to find any particular test. Any page can easily be detached and a colour code permits ready replacement.

As a volume giving every worthwhile piece of information about Tintometer disc methods, the new edition is invaluable, and it can justifiably be regarded as a most useful publication from the point of view of colorimetric analysis in general. The printing is very clear, and the paper of adequate strength for a loose-leaf volume.—J. G. DAVIS.

Process Engineering in the Food Industries, by R. J. Clarke, M.A., A.M.I.Chem.E. London: Heywood & Co. Ltd. 60s. pp. 355.

Although not intended for laboratory workers, this introduction to the study of food equipment will be found very useful by all food chemists. It gives a very readable account of the unit operations involved in the food industry. The 16 chapters cover liquid flow, heat exchange and processing methods, filtration, evaporation, distillation, extraction and expression, crystallization, gas flow, drying, size separation, adsorption, centrifugal separation, mixing and gas sorption. Each chapter treats the subject in the logical order of general principles, plant and equipment (design, construction, etc.) and finally a description of the equipment as used in the food industry. The first two sections of each chapter are illustrated by very clear line drawings showing the construction and mode of operation, and the third by photographs of the most commonly used equipment.

The author states that the book has been written for those who are responsible for the management of plant. In the opinion of the reviewer it will be particularly useful for those who, having qualified in some branch of science or technology, take up a technical career in the food industry.

Practically all items of equipment used in the food industry are covered, although some aspects receive scant attention. Thus evaporation and types of evaporators are dealt with in some detail, but little information is offered about condensers. Some recent developments, such as freeze-drying and the 'instantizing' of milk powder are not mentioned.

An attractive feature is the summary of advantages of a particular type of equipment.

This most readable book fills a gap in the literature, for example between the now gigantic 'Perry' and such specialist works as Farrall's 'Dairy Engineering'. We may express the hope that further editions will not become much larger. There might be a case for expanding the references, especially technological ones, and the index in future editions. The book is well produced and easy to read.—J. G. DAVIS.

The Life of Sir Alexander Fleming, by André Maurois. London: Constable & Co. 1959. 25s. pp. 293.

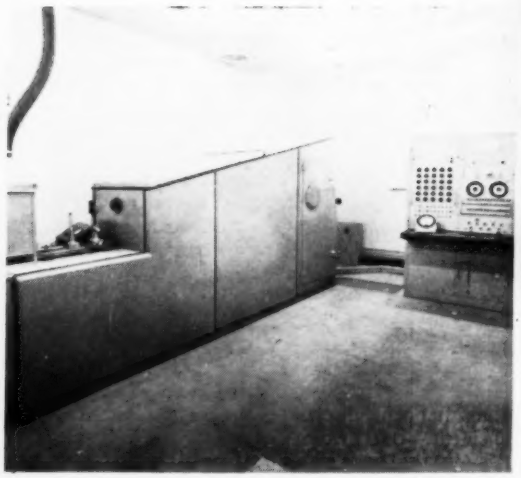
The scientific reader must inevitably feel reservations towards the biography of a scientist written by a layman. A scientist, as a scientist, is inseparable from his work; his actions and decisions are governed by a complex. This is woven out of reactions between his temperament, his mental attitudes to the content of his chosen field, and the stream of scientific events closest to him. Most scientists believe that none of this can be understood by one who can only experience it at second hand. That M. Maurois, as the writer of such a biography, experienced similar beliefs, is indicated in his foreword. Whatever these doubts and hesitations may have been, the text of the book shows that they were roundly defeated, and so will be those of the reader.

The biography creates first and foremost the discernible portrait of a man, evidently sensitive and therefore shy and inaccessible, so that the portrait still remains something of a sketch and a conjecture. This much, perhaps, was made easier for the biographer since Fleming* kept a great deal of his life completely separate from his laboratory, spending it amongst artists, the temporary soldier-companions of a territorial regiment, and in the Suffolk countryside. In addition, however, M. Maurois has achieved both a clear understanding of Fleming's work as a medical research worker, and a valid perspective on an interesting piece of scientific history. These were the early developing years of preventive medicine, when bacteriologists were groping their way to the development of effective bacterial vaccines. Fleming, as a young medical graduate, was drawn into the Movement under the shadow of Sir Almwroth Wright, who dominated the environment of the Inoculation Department at St. Mary's Hospital like a St. Paul of prophylactic bacteriology. During these early years, spanning the first world war, come some of Fleming's important contributions to the study of infective processes—notably his clear demonstration that healthy, living tissue is probably the most powerful disinfecting agent of all. Thus powerful chemical germicides, by damaging living cells, may in fact cause more harm than good, for Fleming also showed that these substances were themselves rendered less effective by the presence of organic matter. The principles of wound disinfection that he established, remain the guiding principles of good surgery to this day, and the criteria of a good disinfectant that he laid down, were eventually applied to penicillin. It is inevitable that in the lay mind penicillin should overshadow all Fleming's other work; it is to the credit of the biographer that this discovery emerges as a blazing, flamboyant and yet somehow scientifically trivial epilogue to his work. Penicillin has proved a transcendantly powerful chemotherapeutic weapon, but so was 606, and so are many of the multitudinous new antibiotics used today. The principles of wound disinfection will still be true long after penicillin has become an interesting historical incident.—G. BELYAVIN.

*Sir Alexander Fleming was one of the original members of the Scientific Advisory Committee of Laboratory Practice.

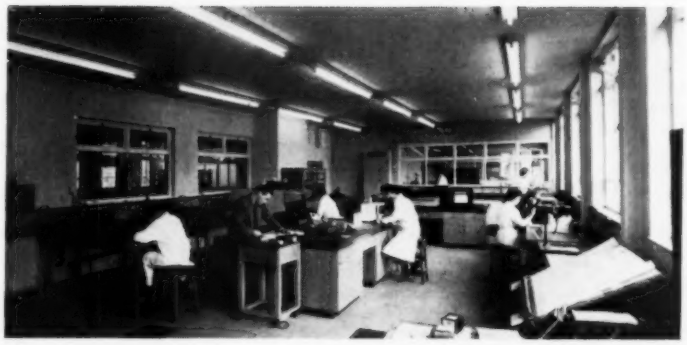
The new wing of the Central Analytical Laboratory of Pilkington Brothers Ltd., at Eccleston Grange, near St. Helens.

PILKINGTON'S LABORATORY EXTENSIONS



Above: **The chemical balance is the starting point of all analyses and in this new extension, qualified staff work with instruments designed to give speed as well as accuracy in this work.**

Left: **This direct-reading spectrograph is used for the rapid analysis of raw materials and glasses and once a sample has been prepared, this procedure can be completed in a matter of minutes compared with several days under the old techniques.**



In this laboratory physical properties such as expansion, density and viscosity of a large variety of glasses are measured and checked regularly.

THE extension to the Central Analytical Laboratory of Pilkington Brothers Ltd., at Eccleston Grange near St. Helens, Lancs., completes a unit which is one of the most up-to-date of its kind in the world's glass industry.

Built at a cost of £100,000, the new wing doubles the existing floor space by adding a further 8,700 sq. ft. to the existing 8,000 sq. ft., and laboratory bench space is increased from 570 ft. to 1,300 ft.

Provided to meet expansion in the field of scientific and technical control of raw materials, the extension houses equipment of the latest type, including a £17,000 spectrometer which is only one of three in use in Britain today.

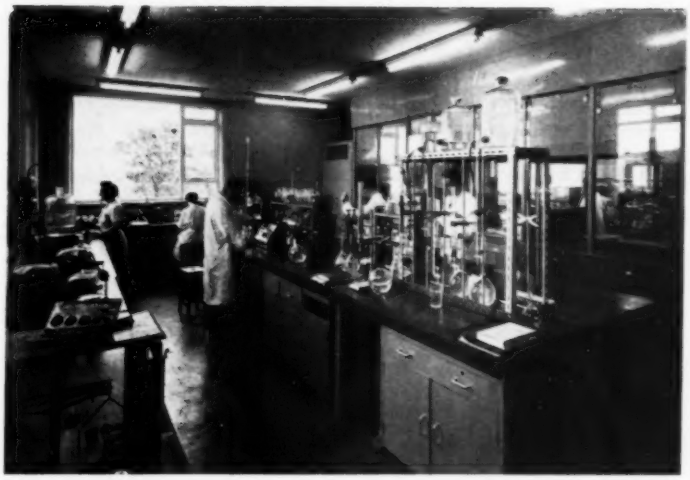
This instrument incorporates electronic recording equipment and is capable of giving analytical results which once took several days to complete, within a matter of minutes.

The complete laboratory is responsible for almost all the analytical work within the Pilkington Group, which includes plants in many parts of the world. Some 22,000 samples are checked in the laboratory a year.

The two storey extension is built as a wing to the existing building and has 17 laboratories of varying size, together with offices, a statistics section, stores, kitchen, dining room to house 45 people, and cloakrooms.

The west elevation is glazed with plate glass but the east side is glazed with Insulight double glazing units to provide maximum heat insulation where temperature control is important.

The ground floor includes a large spectrographic block which is equipped with instrument laboratories; sample preparation and dark room; furnace room; spectrographic electrode preparation; offices; statistics and records; cloakrooms; dining room; kitchen and additional stores accommodation.



A team of analysts investigate new techniques of analysis.

Another aspect of spectrographic analysis where samples representing 1,000 tons of sand down to pin-point size bubbles in glass are examined.

In addition to three chemical laboratories housed within the first floor there are also microscope and grinding and polishing laboratories; physics laboratory; balance and furnace rooms; flame photometer laboratory and an information section.

Scope of Work

To maintain an effective check on quality, the work carried out at the Central Analytical Laboratory involves regular analysis of all raw materials and finished glasses.

Apart from analyses carried out on materials directly concerned with glassmaking, the laboratory at Eccleston Grange also carries out tests for atmosphere pollution stations around St. Helens.

It also checks all effluents to comply with the Rivers' Boards regulations, and a wide variety of other analyses include those on paper, asbestos, cements, metals and deposits of varying types.

Techniques

The development of spectrographic techniques by Pilkington Brothers has been the most noteworthy among the firm's investigations into new methods which may be applied to their own problems of analysis. Samples ranging from faults in glass no bigger than a pin-point to those representing 1,000 tons of sand are dealt with by this method. Flame photometry is used for the day-to-day control of alkali content of glasses and raw materials. Bubble analysis is another problem handled here.

The Central Analytical Laboratory has a staff of 90, of whom 70 are experimental workers. Mr. Frank Hartley, Chief Analytical Chemist, is in charge.

PREPARATION OF MOLYBDENUM CHLORIDES

Convenient methods were developed at the National Bureau of Standards for preparing molybdenum trichloride and molybdenum tetrachloride in satisfactory yields. The trichloride was prepared by an improved method in which molybdenum pentachloride is reduced with excess hydrogen at 125° C. and a pressure of 100 p.s.i. or higher. The tetrachloride was prepared by a newly developed method in which the trichloride is reacted with the pentachloride at 250° C.

THE tri- and tetrachlorides of molybdenum can now be easily prepared by two convenient methods developed at the National Bureau of Standards in work partially supported by the Army's Springfield Armory. Both laboratory procedures involve reactions with molybdenum pentachloride, which is commercially available. Good yields are obtained under recommended temperature and pressure conditions.

As neither chloride can be obtained commercially, laboratory preparation is the only source of these compounds. Previous methods of preparation are inconvenient and time consuming, or else yield an impure product. For example, the reaction between molybdenum pentachloride and hydrogen at a temperature of 250°C. and at atmospheric pressure gives a 5 per cent yield of the trichloride after a period of 12 hours. With the improved method, lower temperatures and higher pressures are used, producing 97 to 98 per cent yields of nearly pure material in 12 hours. Since only a few methods are available for preparing the tetrachloride, the newly developed method provides a valuable source of this low-valent molybdenum compound.

The present methods for both chlorides resulted from experimental studies conducted by D. E. Couch and A. Brenner of the Bureau staff. The trichloride was prepared by reducing the pentachloride with excess hydrogen. Ordinary high-pressure equipment, a one-litre steel bomb, was used for 50 to 500 g. batches. Molybdenum pentachloride inside the bomb was treated with hydrogen at pressures from 100 to 1,750 p.s.i. while the bomb was heated in an external resistance-type furnace to temperatures ranging from 25° to 275° C. The trichloride was obtained in satisfactory yields as long as excess hydrogen was present, temperatures were between 125° and 194°C., and pressures were 100 p.s.i. and above.

The tetrachloride was prepared from a finely ground mixture of molybdenum trichloride and molybdenum

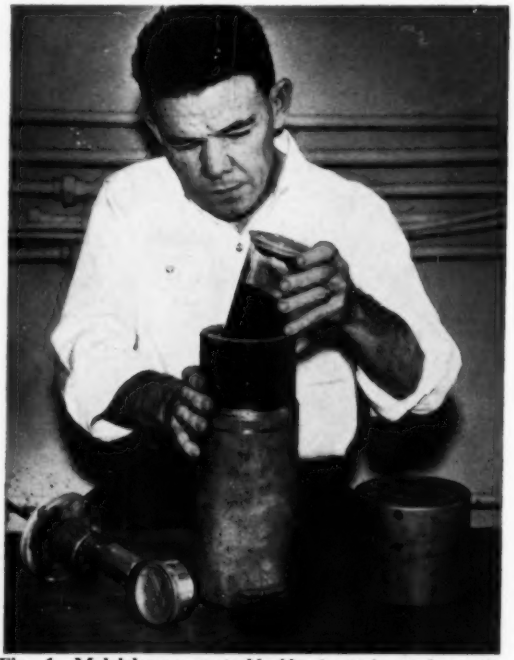


Fig. 1. Molybdenum pentachloride (centre), used at the National Bureau of Standards as a source of the tri- and tetrachlorides, is placed inside a steel bomb and hydrogenated at the desired pressure. High temperatures are produced in a furnace containing the steel bomb. The tetrachloride is prepared by heating a mixture of the trichloride and pentachloride.

pentachloride. A glass tube containing about 5 g. of the mixture was sealed in an inert atmosphere and placed inside a steel bomb. Both were then heated in a furnace. A 2:1 mole ratio of pentachloride to trichloride gave the best results with respect to reaction time. At 250°C., the reaction was about 97 per cent complete in 20 hours. The completeness of the reactions was determined by an assay for molybdenum trichloride based on its insolubility in 1:1 hydrochloric acid.

As chemical analysis of these compounds can be deceiving, X-ray diffraction patterns of various molybdenum chlorides prepared by other methods were compared with those of the tri- and tetrachlorides prepared as described above. The X-ray patterns of the trichloride prepared by hydrogen reduction and by thermal decomposition were identical. The patterns for the tetrachloride obtained from the trichloride-pentachloride reaction showed sharp peaks similar to those obtained with other pure samples of molybdenum tetrachloride. None of the peaks corresponded to those for lower- or higher-valent molybdenum chlorides. Thus, the data confirmed the identity of the reaction products of the newly developed methods, indicating that these methods are satisfactory laboratory techniques.

ADVANCES IN LABELLING MATERIALS

by Frederick T. Day

LABELLING processes have many applications in all fields of industry and research and the introduction of new materials used in the manufacture of equipment and machinery of all kinds has brought about new types of labelling mediums and materials. Among these is the heatsealing or heatfixing process of applying thermoplastic labels by heat and pressure without the aid of moisture. Perhaps the most advanced form of labelling is the self-adhesive or pressure-sensitive label, and new recipes of pre-gummed label papers have been devised for canning, deep freeze storage and for labelling products for export to cold climates. Special tropical label papers are made for goods designed for export to the Middle and Far East giving first-class adhesion to surface and withstanding the heat and rigours of damp and moisture without peeling.

New types of cellulose transfer papers have been formulated for the purpose of printing slide off transparencies; these provide a way of labelling metals, plastics, wood and other hard surfaced material with a permanent brand mark.

The label today has gone far beyond the former accepted conception of function of merely identifying the product; it now adds the 'hall mark'—the appeal and the grade to the goods.

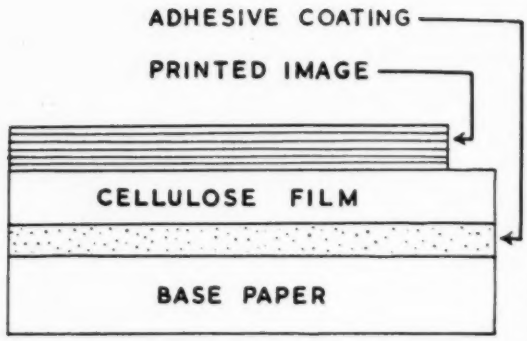
In the field of manufacture, labelling is now accepted as part of the process of manufacture and often marketing the merchandise. The label, by its shape, colour, design or appeal, serves a purpose in the chain of machinery or equipment presentation. The pressure sensitive label is now used in the laboratory where it may be quickly pressed on to any surface under test or evaluation for the purpose of adding data and other recorded matter. Items and materials are often coded and marked in batch order as a temporary measure, the label being stripped off when no longer required. Equipment and machine parts may be coded, priced and labelled up to the point of distribution or usage. This calls for temporary labelling for which the self-adhesive label is most suitable.

Here is a brief review of labelling mediums now available for labelling, branding or marking glass, wood, plastics, tinplate, lacquered surfaces, metals, polished steel and other materials used in the manufacture of laboratory equipment.

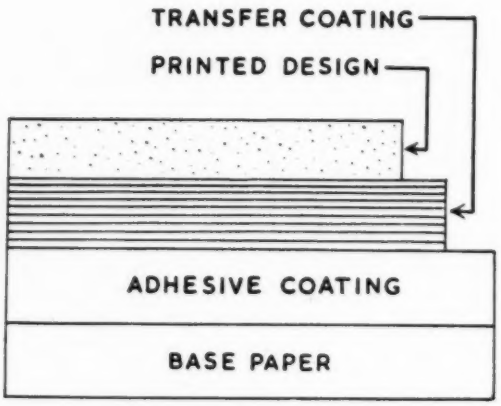
Pressure sensitive labels for temporary labelling of surfaces are obtainable in various shapes and sizes in colours which enable the materials to be coded or quickly identified. They are merely pressed on to the surface and peeled off when no longer required. They adhere to ceramics, all plastics, metals, plain or lacquered tin, rubber, waxed surfaces and may be used in freezing or tropical conditions. Ideal for use as data labels for materials under test, they may be applied by hand or by automatic methods.

Heatfix or heatseal thermoplastic labels for the permanent branding and sealing of products, particularly those filmic wrapped, are applied by heat and pressure by hot plate or iron or heatsealing unit. Heatseal methods of labelling are clean as the absence of water and liquid adhesive ensures freedom from any kind of moisture. Products made from acetates, rigid and semi-rigid plastics, printed surfaces, cans, drums and tins, aluminium containers are some examples of the types of surface for which they are specially suited. There are heatsealing papers made for use in tropical countries and this grade has a high melting point. The standard grade of paper begins to block at 140° F., and is normally tacky at 180° F. The temperature of the activating plant is higher than this, sometimes by as much as 100° F. Heatfix

Labelling for marking chemicals in transit.



SLIDE OFF TRANSFER



SIMPLEX TRANSFER

The make-up of transfer papers.

labels may be obtained in any colour and the special thermoplastic coating is applied to fabrics, cloths, linens and paper base material.

Slide-off cellulose transfers are a permanent form of labelling, perhaps better described as a hall mark or brand for the product. Many types of machinery and equipment are marked or branded with a transfer, the design being carefully drawn up as a permanent form of label known by its shape and colour. There are two main forms of transfer, the slide off type which is a transparency and easy to apply after immersion in water for a few seconds, and the industrial simplex transfer where the design or image is printed negative. In this latter case, the transfer label is applied face downwards, the backing sheet being peeled away after damping.

Cellulose transfers look their best when printed by silk screen process of printing where the rich colours of the printing ink are seen at their best. This process is very practical for a short run in several colours. They are both easy to apply and handle well without damage.

Pre-gummed or gummed label papers. White, tinted and clay coated, metal lined and other basic papers are coated with dextrine or pure gum arabic and many other special formulae and today a label paper is made which will adhere to most difficult smooth, rough or soft surfaces. The correct adhesive must be selected and here the specialist should be consulted. This form of labelling is the established method of labelling materials, surfaces, products and packages either temporarily or permanently. They may be printed by all the current processes in one or several colours. The label specialist supplies these labels in unit form packaged in specified quantities, in coils or reels perforated and in flat sheets suitably packed.

The application of moisture to a gummed surface is most important if a good and permanent stick is to be ensured. Too much moisture will wash away part of the adhesive coating while too little will hardly activate the gum. Moisture is best applied by some form of labelling device which ensures a good overall spread of water.

Liquid adhesive and plain paper. This form of labelling still has many applications in industry in the packing and labelling of merchandise. The adhesive may be animal, vegetable or mineral and here again the correct recipe should be used for each individual labelling or sealing process. This method is suitable for labelling cans and drums, and wooden cases and for sealing the flaps of cartons and containers made from fibreboard corrugated materials. Adhesives based on silicate of soda dry out very rapidly so that the lids of cans holding liquids should be kept on firmly. Adhesives in this group are applied by hand methods, semi-automatic or fully automatic machine methods.

New International Air Freight Labels

This year new labelling devices in the form of standard design labels are to be used for marking merchandise to be transported all over the world. The labels are designed to mark fragile merchandise and perishable goods while another type indicates 'This way up' stacking of packed goods. Fragile goods are portrayed by a broken wine glass as an illustration on the label, perishable goods by a design which incorporates fish, meat, flowers and fruit and 'This way up' by two arrows. It is hoped that this form of label will help in the handling of goods all over the world in such a way as no one language will in the many countries which goods may travel on their journey.

Society for Applied Bacteriology

At the Annual Meeting of the Society for Applied Bacteriology, held in London on July 8, the following were confirmed in office:

Hon. President, Mr. D. A. McKenzie;
Hon. Treasurer, Mr. G. Elis Jones;
Hon. Editors, Dr. S. E. Jacobs and Dr. C. A. E. Briggs;
Hon. Publications Manager, Mr. A. H. Walters;
Hon. Advertising Manager, Mr. E. J. Mann;
Members of Committee, Dr. Eve Billing, Mr. N. J. Butler, Prof. E. L. Crossley, Dr. J. G. Davis, Mr. B. M. Gibbs, Mr. D. J. Jayne-Williams, Dr. Jane Meiklejohn, Dr. G. C. Ware, and Dr. M. Woodbine.

After eight years as Hon. Secretary of the Society, Mr. G. Sykes announced his resignation. His place will be taken by Dr. Ella M. Barnes, D.Phil., Dip.Bact., Low Temperature Research Station, Downing Street, Cambridge. This change will take place towards the end of October.

News from the British Association of Chemists

Proposed New Professional Institute of Chemical Technology

One of the main objects of the B.A.C. is to promote education in chemistry, the efficient practice of chemistry and the application of chemistry to industry.

In pursuance of this objective, the Association have been perturbed by the large numbers of young people leaving our technical colleges each year with National or Higher National Certificates in Chemistry who proceed no further.

The actual figures for England and Wales from 1954 to 1958 are shown in the Table below.

Of the students who get their H.N.C. in Chemistry only a very small proportion, probably less than 10 per cent for the country as a whole, proceed to A.R.I.C. by examination. The proportion varies from college to college. In very large well-established colleges it may be as high as 20 per cent. In the smaller ones, it may be nil.

In other words some 10 per cent of these students become corporate members of a recognized professional body of chemists. The remaining 90 per cent are left high and dry, although numerically they constitute an important part of the chemical manpower of the country, a state of affairs which is creating considerable unrest among both students and staff.

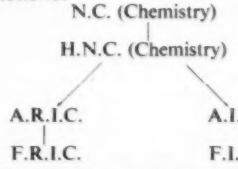
It is argued that if every young man getting his H.N.C. in some branch of engineering can expect in due course to be recognized as a fully qualified engineer, why should not every man who gets his H.N.C. in chemistry be able to reach full professional status as a chemist?

The problem, of course, is not an easy one to solve. The Royal Institute of Chemistry is unwilling at present to reduce its standards or to open a lower grade of membership. Nevertheless, the time required by a part-time student to complete the full A.R.I.C. course is so great that the student is frequently unable to proceed because of increasing responsibilities outside. Frequently too a man's job does not require a knowledge of pure chemistry beyond H.N.C. standard—it requires a knowledge of a particular technology.

Advantages of Membership of the B.A.C.

- Minimum Salary Scales.
- Free Legal Advice on Professional Matters.
- Appointments Service.
- Unemployment Benefit.
- Negotiations with Employers.
- Group Scheme for Private Medical Treatment.
- Certain advantages in connection with Insurance.
- Trading Scheme.
- Benevolent Fund.
- Lectures, Discussions and Social Functions.

The solution, therefore, would appear to lie in the formation of an entirely new professional institute to be called the Institute of Chemical Technology. The professional pattern would then be as follows:



The precise requirements for the associateship and the fellowship of the proposed new institute have still to be decided, but in broad outline it is proposed that students who reach a standard in a technological subject suitable for endorsement on their H.N.C. in chemistry, should qualify for associateship of the new institute.

Fellowship would be awarded for a further five years technological experience plus, possibly, a further technological qualification of an accepted standard.

The B.A.C. are calling a meeting of technical school teachers in the Crewe Arms Hotel, Crewe, on Saturday, October 17, 1959, at 2 p.m. to consider the whole matter. Every technical college in Great Britain preparing students for H.N.C. in chemistry will be invited to send one representative. Travelling expenses will be paid by the B.A.C.

Should the meeting decide to go ahead, a company without profit will be registered under the Board of Trade and this company will then proceed to form the new institute, draw up by-laws, etc., etc.

Although the Association has undertaken the responsibility and expense of getting the new institute established, it should be pointed out that, once formed, the Institute of Chemical Technology will be completely independent of the B.A.C. It will be governed by its own Council elected by its own members.

Year	*Ordinary National Certificate in Chemistry*		*Higher National Certificate in Chemistry*	
	Entered	*Passed*	*Entered*	*Passed*
1954	1,559	931	767	518
1955	1,642	1,012	959	681
1956	1,893	1,184	1,018	711
1957	2,178	1,295	1,165	791
1958	2,509	1,459	1,269	882

B.A.C. and F.I.C.C.I.A.

The Association is playing a very active part in the work of F.I.C.C.I.A., the European body which is concerned with interests of professional chemists and represents them at the International Labour Office in Geneva. B.A.C. representatives have recently submitted reports to this body on patent law in Great Britain and on pensions for supervisory employees in the British chemical industry.

Another report is nearing completion on the comparative standards of the various examinations in chemistry held in the countries of Western Europe.

Personal Notes

Mr. C. S. Garland

Mr. C. S. Garland, past President of the B.A.C., who retired as President of the National Union of Manufacturers last year, has been appointed chairman of the National Union of Manufacturers Advisory Service (NUMAS).

Life Members

The following have been elected Life Members of the Association:

Essery, R. E. Aged 65. Elected Member 1918 (London Section).

Ninniss, W. Aged 65. Elected Member 1924 (Liverpool Section).

Westlake, E. P. Aged 65. Elected Member 1925 (London Section).

Obituary

Fore, T. E. Aged 63. Elected Member 1928 (Liverpool Section).

Hird, C. E. Aged 53. Elected Member 1935 (Notts & Derby Section).

Mosby, D. H. Aged 56. Elected Member 1931 (Notts & Derby Section).

All correspondence and enquiries concerning this Association should be addressed to G. R. Langdale, Esq., The British Association of Chemists, Nomination Dept., 14 Harley Street, London, W.1. Tel.: Museum 7021.

Laboratory Note-Book

UNDER a contract awarded by the International Atomic Energy Agency, a research project is to be carried out in London which may have an important bearing on the understanding, diagnosis and treatment of radiation sickness as well as on the possibility of preserving food and drugs by irradiation. The research is to be conducted at the Chester Beatty Research Institute under the guidance of Dr. Peter Alexander, and in collaboration with the Microbiology Department of the Imperial College of Science and Technology in Kensington. The sum of $6,000 has been sanctioned by the Agency for the first year of the project.

One of the chief hurdles so far in the sterilization of food has been the fact that many bacteria possess a high level of resistance to ionizing radiation. In some cases the dosage required for their destruction may prove harmful for the food itself. Experience so far has shown that food sterilization may require between 200,000 to 6,000,000 roentgen units of radiation. The task, therefore, is to increase the radio-sensitivity of bacteria by some artificial means before they are subjected to radiation, so that a low radiation dose may prove completely effective and safe.

Scientist on Goodwill Missions

As a result of talks with Dr. Edwards of Bradford Institute of Technology, Mr. K. G. Sinclair, Chairman of the Griffin & George Group of Laboratory Equipment Manufacturers, has awarded two Travel Fellowships to Dr. Peter Ramwell of the Department of Pharmacy at the Institute.

Mr. Sinclair tells us that, following the formation of Griffin & George (Research & Development) Ltd., the research group headed by Dr. A. J. P. Martin, F.R.S., it became evident that there was a need for a Fellowship which would provide senior workers of established repute with facilities for travel abroad.

The G. & G. Fellowships, in consequence, are intended for young scientists who already have made a worthwhile contribution to instrumentation, and who may, with suitable encouragement, make more significant advance than would otherwise be possible. It was decided, therefore, in consultation with Dr. Edwards, that the first of these Fellowships should be in biological instrumentation and awarded to Dr. Ramwell for his work and interest in rapid response respiratory gas analysis.

During his first journey, in June and July, Dr. Ramwell visited Paris, Frankfurt, Brussels and Berlin, where at many of the teaching hospitals he was able to see some of the work in his own field of artificial kidney installations and anaesthetics; he visited Basle during late August and September.

The Polarographic Society Medal

A silver medal, to be known as the Polarographic Society Medal, is to be awarded periodically in recognition of outstanding work in polarography, on the recommendation of a special committee.

The first award has been made to Prof. J. Heyrovsky for his discovery of the polarographic method in the nineteen-twenties and for the subsequent major contributions to the subject by himself and his students.

The medal was presented by Prof. W. H. Linnell, Vice-President of the Polarographic Society, at the Opening Ceremony of the II International Congress of Polarography on August 24, 1959.

Space Humour

In case any of our readers missed it—and we think it is too good to miss—we must tell the story which is related in the June 6 issue of *Chemistry and Industry* concerning the space monkeys Able and Baker and their much publicized press conference. At the end of the conference one of the monkeys was seen walking out of the Library of Congress with a book under each arm—one was the Bible and the other Darwin's *Origin of Species*. The monkey is alleged to have been heard muttering: 'Am I my keeper's brother?'

The MS7 Mass Spectrometer

Metropolitan-Vickers Electrical Co. Ltd. has just completed the first production model of the MS7 mass spectrometer, and this is shown in the accompanying photograph. The instruments now being produced are for the National Physical Laboratory, the Services Electronics Research Laboratory, the Mond-Nickel Company and the U.K.A.E.A. Recently, orders for this instrument were also received from France and America.

The MS7 mass spectrometer has been designed specifically for the purpose of measuring minute impurities in solid substances using the spark ionization technique. It will be of invaluable use in fields of science and engineering where it is essential to use materials of the highest purity, such as nuclear engineering, semi-conductor research and manufacture, and in the development of non-ferrous metals and alloys.

Some of the materials which have been successfully analysed down to 0·01 p.p.m. with the prototype model include uranium, reactor grade graphite, germanium, selenium, silicon, gallium-arsenide, magnesium, titanium, tungsten, iron, copper, aluminium, tin and nickel-chromium alloys.

The mass spectrometer is a double focusing instrument of the Mattauch type, in which positive ions, representative of the sample composition, are produced when a high-voltage spark occurs between two electrodes of the sample material placed close together in vacuum. After passing first through an electrostatic analyser and then through a magnetic analyser the ions come to focus according to their mass, but irrespective of their initial energy, as a series of lines on a photographic plate.

For the analysis of impurities in solids the photographic plate is used as an integrating device, and a series of exposures of gradually increasing length are taken (a rack mechanism allows up to 10 exposures to be recorded on the same plate and the exposure is accurately determined by the total integrated charge falling on the monitor collector). The concentration of the impurity is estimated from the intensity of the lines on the longer exposures, and with this technique concentrations down to the level of 0·01 p.p.m. can be estimated.

The method is particularly useful for giving a general picture of the impurities in a solid. The whole mass range from 7-240, covering all elements, can be recorded in a single exposure of the photographic plate. Compared with emission spectroscopy the spectra are simpler and the elements easier to identify. Moreover, qualitative and semi-quantitative analyses can be carried out without extensive calibration.

The MS7 mass spectrometer.

LABORATORY EQUIPMENT & APPLIANCES

A Compressed Air Dehydration Unit

A machine which can supply an uninterrupted flow of air to zero humidity and clean to 0·5 micron, which is also fully portable, and which can operate continually 365 days a year is available to many branches of industry—including hospitals, clinics and laboratories—who rely on clean dry air for vital research and manufacturing processes.

The new Pathfinder cabinet achieves dryness and cleanliness through refrigeration. In its standard form, the cabinet supplies 10 cu. ft./min. of air at up to 60 p.s.i.g. or 10 c.f.m. at 15 p.s.i.g. at any required humidity between zero and ambient. Occupying a floor area of less than three feet square, under six feet in height, and fitted with castors, it can be moved easily from one workshop or laboratory to another.

The Pathfinder air pump cabinet provides clean, dry, pressurized air, the air being supplied by two Williams and James horizontal two-stage compressors of the oil-free carbon ring type for pressures up to 60 p.s.i.g. at 10 c.f.m. or alternatively a fully rotary type compressor with an output of 10 c.f.m. at 15 p.s.i.g. Initial filtration at the compressor intake is by means of a Vokes type HDI five-ply filter. To obtain greater efficiency through maximum precooling, the output of a fan mounted on the end of the motor shaft is directed by a two-way ducting to the compressor heads in the case of the 60 p.s.i.g. compressors. Where the 15 p.s.i.g. compressor is used, the compressor itself has its own built-in cooling fan. The suction side of both types of compressors are in heat exchange with the low temperature dehydrated air and provide a 'lower than ambient' intake to the compressors.

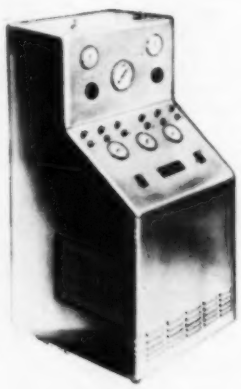
The output from the compressor passes to a 'Compressed air to ambient' heat exchanger or aftercooler. A suitable trap device ensures draining of the condensate at this point. From the aftercooler the air is piped to the dehydration unit, which is designed to reduce the air temperature to —40°C. and subsequently reheat to ambient. Provision is made to prevent ice particles from being carried through to the outlet of the machine.

The reduction of the air temperature to —40°C. and reheating to approximately 21°C. results in a relative humidity of 0·641 per cent at the air outlet from the machine, at 15 or 60 p.s.i.g. Where this air is used to pressurize assembly cabinets or similar equipment at pressures lower than that of the machine output, a marked improvement on the relative humidity is obtained.

The dehydration unit which contains the 'compressed air to refrigerant' heat exchanger assembly is designed to operate with a refrigeration condensing unit employing the customary refrigerant Monochlorodifluromethan (known to the trade as Arcton 4) and is capable of giving a continuous air outlet dew point temperature of better than —40°C. for a period in excess of 12 hours. It is constructed in duplicate, so enabling a continuous cycle to be performed indefinitely.

The ice build-up resulting from dehydration is dispersed by a Pathfinder automatic defroster. Condensate formed during defrosting is carried away to an automatic drain. An important feature of the Pathfinder cabinet is that any particles of oil or solidified matter which have passed the initial filter are removed from the air during the dehydration process, being trapped in the ice field and drained away with the condensate. This effective method of dirt removal provides cleanliness to 0·5 microns and obviates the need for an elaborate filtration system.

In addition to providing for removal of the condensate, the automatic drain has two other functions. Firstly it serves as a small reservoir of air, and secondly it provides a water washing action which still further ensures cleanliness of the air. A drain plug and filter provides for removal of dirt from the reservoir, which is also constructed in duplicate, with each half serving its own dehydration circuit. (Sole Selling Agents: B.M.B. (Sales) Ltd., Crawley, Sussex.)



The compressed air dehydration unit.

A new glass tube cutter.

Glass Tube Cutter

This apparatus provides a safe, convenient and easily operated means of cutting hard (borosilicate) or soft glass, up to 3 in. (7·6 cm.) in diameter.

With this equipment no special skill is required. The tube is merely rotated against the cutting wheel and the resulting scratch mark is then held against the hot wire, localized heat causing the tube to part neatly. An adjustable backstop makes sure that the scratch is cut accurately around the circumference of the tube.

All operations can be accomplished quickly, simply and accurately. (Manufacturers: Electrothermal Engineering Ltd., 270 Neville Road, London, E.7.)

A Low Power Stereoscopic Magnifier

The new Sterimag low power stereoscopic magnifier has uses in every laboratory and workshop. The microscope head is fitted to a substantial long arm stand with a heavy base; this is the most generally useful type of stand for this sort of microscope as it allows a wide range of objects of different sizes to be examined conveniently, and allows the microscope head to be swung aside when not in use. The optical head is fitted with a swivel joint so that it can be used in an inclined position, and the

The new Sterimag low power stereoscopic magnifier.

instrument can be bought with a built in spot lamp, run off a transformer housed in the base.

Two models are available, one with a magnification of x. 20 which has a field of view which can be seen at one time of 10 mm. diameter and one of x.10 magnification with a field of view of 20 mm. Large objects can be examined by moving the microscope over the object. Each has a free working distance of approximately 7 in. from the object to the microscope head, which gives plenty of room for working under the microscope.

In laboratories Sterimags are used for dissecting, counting, examining products and materials and in many other ways. The object is seen magnified, right way up, and in striking stereoscopic relief, and with great depth of focus.

The performance is of a very high standard, with a wide field of view and crystal sharp images, but the price is reasonable as the Sterimags have been tooled for quantity production. The price of either model with built in spot lamp is £34 and without spot lamp £30. (Manufacturers: C. Baker Instruments Ltd., Metron Works, Purley Way, Croydon, Surrey.)

Non-Cartridge type Demineralized Water Units

Water demineralizing, or de-ionizing, units are now superseding the still and distilled water delivered in carboys as a source of supply of purified water for laboratories and similar establishments. A feature of many such units, however, is their reliance on detachable cartridges of ion exchange resins which are returned to the supplier when exhausted.

The Mark 4 and Mark 5 portable 'Deminrolit' plants have been designed for easy 'on the spot' regeneration of the exhausted ion exchange material, thus obviating the need for detachable cartridges and replacements. Since regeneration requires only very small amounts of inexpensive chemicals running costs are reduced to less than a half-penny per gallon of demineralized water produced.

Both plants consist of a pair of sealed columns charged respectively with 'Zeo-Karb' cation and 'De-Acidite' anion exchange resins, the water being passed through the columns in that order. Flexible connection and delivery tubes, with a multi-valve control system, facilitate operation and regeneration. A built-in dial type conductivity tester enables 'spot' checks to be made on the quality of water being produced. By this means the point at which regeneration becomes due may be determined precisely.

Permutit Mark 4 portable Deminrolit plant.

Regeneration involves flushing the cation column with a dilute solution of hydrochloric acid and the anion column with dilute caustic soda or soda ash solution. Both columns are then rinsed with water when the plant is ready for further use.

Either plant is available as Type 'E' or Type 'F', the difference being in the type of resin used in the 'De-Acidite' column. The former produces a demineralized water comparable to commercial distillate while the latter produces a much higher quality.

Output between regenerations will depend on the raw water quality—that from the Type 'F' plants being somewhat less than that obtained from Type 'E'. Using London Area (M.W.B.) mains water the output from a Mark 5 'E' plant will be approximately 50 gallons while the same plant using Manchester water will produce about 300 gallons.

Flow rates are unaffected by the type of plant or quality of the raw water; the Mark 4 produces demineralized water at about 11 gallons hourly—the Mark 5 about 6 gallons hourly.

The Mark 4 is mounted in an upright tubular framework on a small, rubber tyred, two wheeled undercarriage which enables easy transportation between departments. The smaller Mark 5 is equipped with a carrying handle and is designed for bench level operation.

Both plants are constructed throughout from non-corrodible materials and operate at normal cold water tap temperatures and pressures.
(Manufacturers: The Permutit Co. Ltd., Permutit House, Gunnersbury Avenue, London, W.4.)

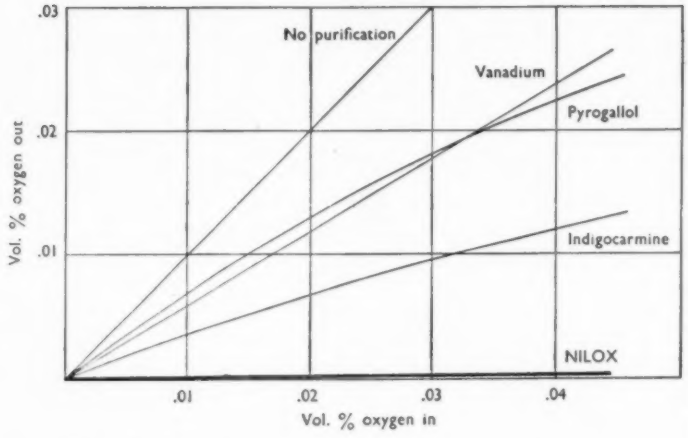
Gas Purification

The Nilox gas purification system enables the laboratory worker to obtain, on the turn of a tap, a continuous stream of hydrogen, nitrogen, argon, etc., completely freed of the oxygen normally contaminating these gases as supplied in cylinders. At a negligible expense in chemicals, ordinary commercial nitrogen can be purified to a degree much superior to high purity commercial nitrogen. The apparatus is also a great time saver for operations requiring inert atmospheres, organic syntheses, carrier gas methods, glove box work, deoxygenating aqueous media, etc. The method does not require the presence of hydrogen for the catalytic combustion of the oxygen and is free from hazards.

The primary absorbent is a chromium salt (Nilox CR.1) in a special scrubber (Nilox N.1) designed for highly efficient gas-liquid exchange. This reagent is oxidised, but is reduced back by contact with a zinc amalgam (Nilox Z.2) in the same scrubber.

For gases highly contaminated with oxygen, a pre-purifier (Nilox P.1),

COMPARISON OF OXYGEN ABSORBENTS
(In similar scrubber)



reagent Q.1 and lead wool (Nilox PB.2) are required. This pre-purifier removes the bulk of the oxygen, while the scrubber finishes off the purification.

The gas stream which may flow at any rate up to 20 litres per hour, passes down the entrance tube and then, turning sideways, into the vertical tail of the helix. At this three-way point, the gas picks up solution CR.1 ascending from the U-shaped bottom tubing. As a result, a chain of liquid drops separated by gas bubbles rises in the helix. On the way up the gas bubbles give up all their oxygen to the continually renewed film of solution enveloping the bubbles all along their way through the helix. At the top, the chain breaks up, the liquid drops joining the bulk liquid in the container, while the purified gas leaves at the top exit. The bulk liquid descends slowly through the bed of zinc amalgam, where regeneration of the solution occurs.

The scrubber is for use with gases already low in oxygen, e.g. 0·01 vol. p. ct. 0_2. For higher oxygen contents, depending of course also on the rate of flow, pre-purification is necessary.

Pre-purification is carried out in a gas wash bottle containing lead wool (Nilox PB.2) and solution (Nilox Q.1). On contact with the lead, the solution Q.1 is reduced to a product which is the primary oxygen scavenger.

The two purifiers in series will also retain acidic and basic impurities, such as CO_2 H_2S, SO_2, Cl_2 NH_3 and amines.

The development of this purification system was rendered possible by the availability of a convenient meter for the continuous analysis of oxygen in gases down to traces not accessible to any earlier method of oxygen assay.
(Manufacturers: Electrochemical Laboratories, 5 Highfield, Wardle Road, Sale, Manchester.)

Laboratory Metal Furniture Units

Improvements have been made in the appearance and durability of a range of all-metal unit furniture. The change-over to the new design gives to the purchaser the benefit of much research work and investigation into what style of unit makes the greatest appeal to the largest number of users. It was found, for instance, that projecting handles were a cause of constant annoyance, and since the pressed metal work of the Griffin-Grundy units offered an opportunity for a change in design, this 'no-projection' feature was incorporated in the new cupboards and drawers with great success. A continuous flange offers finger-grip space over the full width of door and drawer; this gives the units an extremely clean and flush appearance.

Special attention has also been given to the adjustment and alignment of the drawers by the use of a simple cam on the drawer track, which is easily accessible from the front of the unit; a rubber buffer on the track makes for quiet operation. Other features in the range include the choice of many materials and finishes, $1\frac{1}{2}$ in. shelf centres, piano-type hinges, adjustable feet, and flashing strips which conceal all fixings, ensuring that the new metal furniture tones in well with existing installations, with which it is immediately and completely interchangeable.
(Manufacturers: Griffin & George (Laboratory Construction) Ltd., Ealing Road, Alperton, Wembley, Middlesex.)

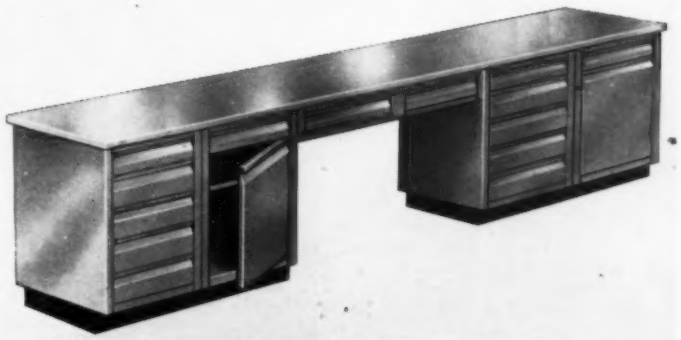
The Eliminac

This instrument, which has been primarily designed for use in laboratories, provides a continuously adjustable low-tension supply of smoothed D.C. replacing the normal lead/acid accumulator. A variable voltage A.C. outlet is also made available. In addition to its normal function it may be used as a charger.

A selenium metal rectifier, connected in a bridge circuit, is used to give full-wave rectification. The parameters of the ripple filter network have been chosen to provide the best possible degree of smoothing for an instrument of this size, weight and price. A meter permanently monitors the D.C. output voltage.

Separate outlets have been provided to allow the smoothing equipment to be by-passed for applications where a moderate degree of superimposed A.C. ripple is permissible. This permits a little extra current to be drawn without overloading the smoothing choke.

The L.T. outputs, which are isolated from the mains, are made continuously variable by the use of a 'Variac' double wound, adjustable voltage transformer. The outputs are, furthermore, insulated from the chassis and metal cabinet. The Eliminac is protected by a 2 amp. cartridge fuse at the mains input.
(Manufacturers: Labgear Ltd., Willow Place, Cambridge.)



An example of a laboratory metal furniture unit, illustrating the new 'no projection' features.

NEWS

General

Fundamentals of Microbiology

A course of about 30 lectures and laboratory work is to be given on the fundamentals of microbiology by N. J. Butler, M.Sc.(N.Z.). The course will be held at the Sir John Cass College, Jewry Street, Aldgate, London, E.C.3, and will be held on Tuesday evenings from 6 to 9 p.m., beginning on Tuesday, October 6, 1959.

The course will form an introduction to microbiological techniques and will be addressed especially to graduates in chemistry, botany or zoology. The course is not designed for those concerned with medical or veterinary applications of microbiology.

The course may be taken either alone, or as the first session's work of a two year course, of which the second year is called 'Applied Microbiology'. Students who attend both years' classes satisfactorily and pass successfully the examination at the end of each year are awarded a College certificate.

The syllabus is as follows:

Historical development of microbiology. Pasteur. Koch. Pure culture technique. Biological stains.

Morphology of bacteria. The finer structure of the bacterial cell. Growth and reproduction of bacteria. The living environment.

Cultivation of micro-organisms. Death of micro-organisms, disinfection and sterilization. Antiseptics. Infection and resistance. Immunological reactions.

Bacteriophage. Viruses. Energy requirements of bacteria. Microbial variations.

Enzymes. Mechanisms of microbial respiration. Metabolic groups of bacteria. The classification of bacteria. Practical use of the Bergey system. Identification of bacteria.

Eubacteriales. Nitrobacteriaceae Rhizobiaceae. Azotobacteriaceae.

The bacteriology of the soil. Pseudomonadaceae.

Manufacture of vinegar. Lactobacteriaceae. Enterobacteriaceae. Bacillaceae.

Actinomycetales. The bacteriology of water and air. Use of bacteria in industrial fermentations.

The morphology of yeasts and their utilization in industrial processes.

Elementary mycology. Study of the morphology of the Phycomycetes, Ascomycetes and Fungi Imperfecti. Antibiotics. Penicillin, Streptomycin, etc. Mould fermentations. Physiology of mould Fungi.

Spoilage organisms and their control. The preparation and preservation of food. Textile microbiology.

Fee for the Course for those residing in the Administrative County of London is £2. 10s., Laboratory Deposit, £1.

Brussels Exhibition

A.S.B.L. LABORAMA, grouping all the Belgian dealers and importers of scientific and industrial equipment, is holding its second Exhibition from October 23 to 29, 1959, in the Salle Internationale Rogier, Brussels.

Almost every trade catering in any way for laboratory, hospitals and industries is now represented in this Exhibition, where can be seen the most comprehensive display of equipment ever assembled under one roof.

Manufacturers' News

Amalgamation

An agreement in principle has been concluded whereby it is intended that A. Gallenkamp & Co. Ltd., will acquire the business of J. W. Towers & Co. Ltd.

The businesses have a long record of successful progress, Gallenkamp being established in London in 1880, with interests mainly in the South of England and overseas, and Towers in Widnes in 1882, with interests mainly in the North.

Both companies now have considerable manufacturing facilities, which in many respects are complementary. Jointly, the Sales, Technical and Distributive organizations will be able to offer to laboratories throughout the U.K. and overseas a most comprehensive range of products and an excellent service.

Because of the complementary natures of the businesses and the fact that there is no significant overlap in the territories of main interests, it is envisaged that with the full co-operation of the staff of both companies a successful merger, without redundancy of personnel, can be achieved.

J. W. Towers & Co. Ltd. will continue to trade as a separate company, and Mr. J. S. Towers has agreed to hold office as Managing Director for a period necessary to ensure a smooth co-ordination of interests.

Publications

Scientific and Technical Conferences

List No. 25 of Forthcoming International Scientific and Technical Conferences, published by the Department of Scientific and Industrial Research, amends and amplifies the information contained in List No. 24 which is superseded.

Tetrahedron Letters

Tetrahedron Letters (published by Pergamon Press Ltd.) will provide a medium for the rapid publication of communications in organic chemistry in preliminary form.

It will be published every two to four weeks, while *Tetrahedron* will continue to appear monthly as the international journal for permanent contributions to organic chemistry.

Water Pollution Research

Since the Joint Committee of the Federation of British Industries and the Water Pollution Research Board was set up last year, two new researches of considerable importance to industry have been started. These are an investigation of the dewatering of sludges and a study of the effects of suspended solids on fish, and the early stages of the work are described in the annual report of the Water Pollution Research Laboratory.

Joint committees have also been set up with the Institute of Sewage Purification and with the River Boards' Associations to maintain the closest possible contact between them and the Laboratory.

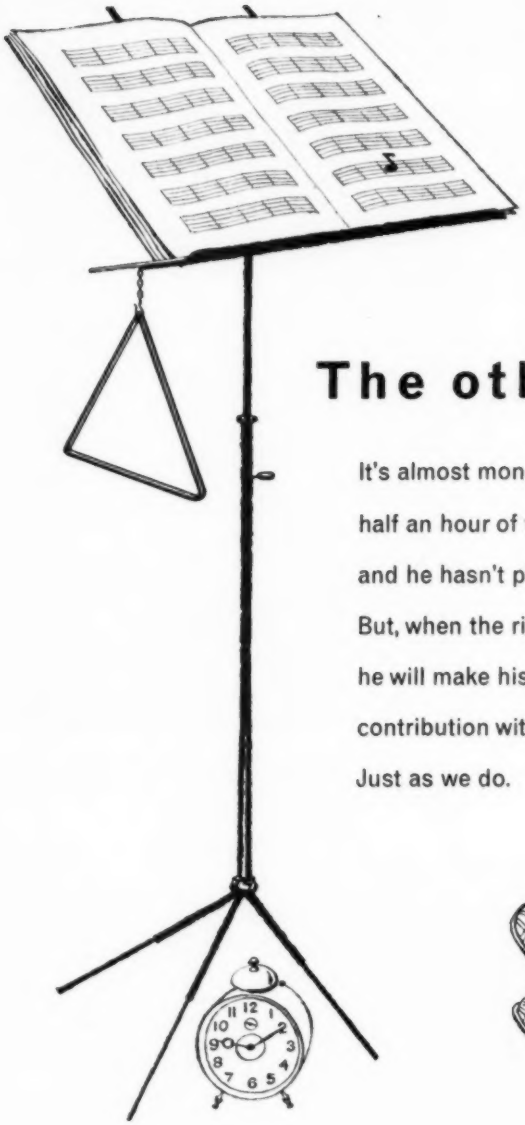
Industrial Waste Waters.—General research has continued on methods of treatment likely to be applicable to a wide variety of industrial effluents and more work has been done on repayment on particular problems of individual firms. These problems have been concerned with processing of milk and eggs; the manufacture of wafer biscuits and chemicals; tanning and electro-plating, and the effect of ship-cleaning detergents on an estuary.

Slaughterhouse wastes.—Longer-term work on the anaerobic digestion of industrial liquors has shown particular promise for slaughterhouse wastes. The Laboratory has gained considerable experience in the treatment of this liquor in a 500-gallon pilot-scale digester, and interest is being shown in the possibility of erecting full-scale plants.

Synthetic Detergents.—A topical item of research is the treatment of synthetic detergents used for household purposes. Detergents reduce the efficiency of plants using the diffused-air activated-sludge process of treatment. Recent laboratory experiments show that the detergent reduces the rate of uptake of oxygen from the air which in this process is blown through the sewage to bring about purification. The effect is most marked when the air supply is only just sufficient to maintain aerobic conditions and this may explain why serious effects are more noticeable at some works than at others.

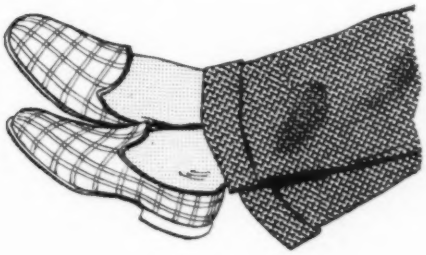
Existing detergents are largely unaffected by the biological processes used for the purification of sewage and the residues cause frothing and other undesirable effects in streams. In the last three years detergent manufacturers have been developing active materials which would be more susceptible to biological attack than those at present in use.

Last year the Laboratory was asked by the Standing Technical Committee on Synthetic Detergents of the Ministry of Housing and Local Government to examine the behaviour of a promising new active material. Tests showed that although this material was not wholly removed in sewage treatment the proportion destroyed was greatly increased.



The other man's job—

It's almost money for jam—
half an hour of the symphony gone
and he hasn't played a note.
But, when the right moment comes
he will make his
contribution with precision.
Just as we do.



Griffin

GRIFFIN & GEORGE

The Laboratory Furnishers

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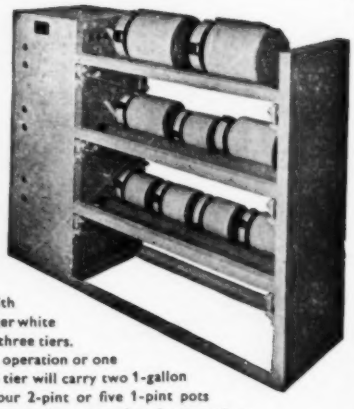
P 3

laboratory ball mills

Available in many types for rolling ceramic, metal and rubber pots from 5-gallon to 1-pint nominal capacities.



Mill illustrated is an extremely useful unit for carrying out several jobs at the same time on one or more materials of varying quantity or time of processing.

Arranged with three separate motors and with three pairs of 2½" diameter white rubber bonded rolls in three tiers. Usable with all three in operation or one or two separately. Each tier will carry two 1-gallon or three ½-gallon or four 2-pint or five 1-pint pots and combinations of these can be operated at the same time

Mill shown is only one of many types available from miniature 1-pint model for processing small quantities of expensive materials to larger 5-gallon model with tilting cradle in which the pot is securely held, charged, operated and discharged without having to lift this heavy pot from cradle.

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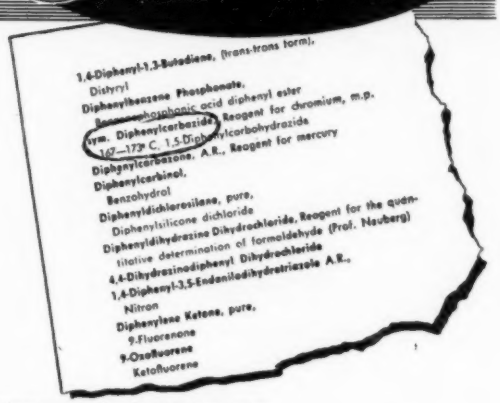

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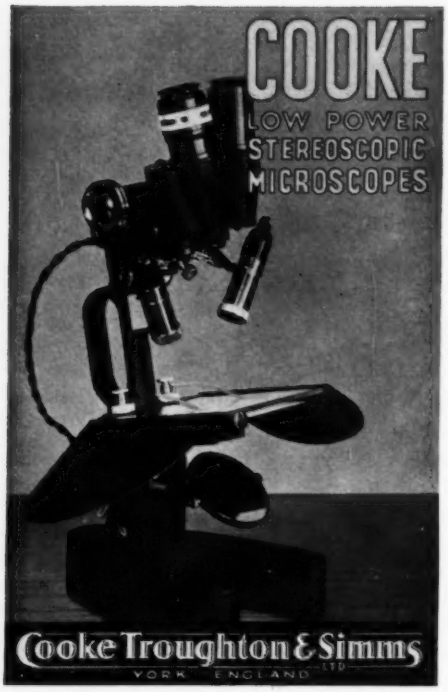

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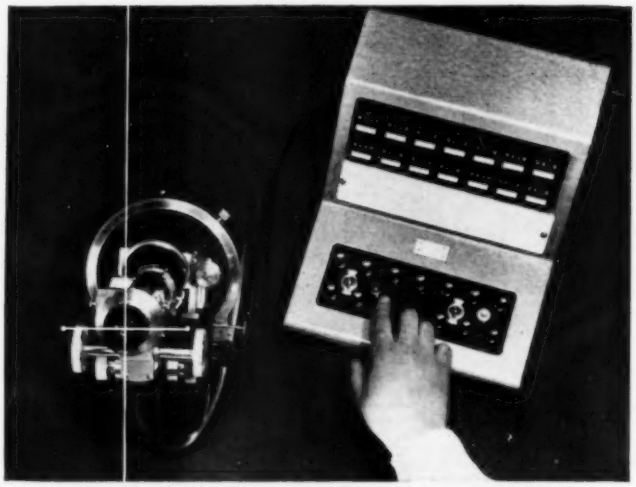

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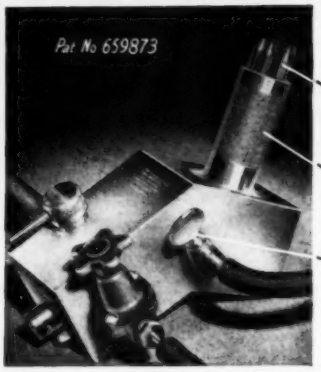

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Index to Advertisers

Adelphi Manufacturing Co., Ltd. cciv
Anderman & Co., Ltd. ccvi
Astell Laboratory Service Co., Ltd. cxcvi
Baird & Tatlock (London) Ltd. .. .. Cover i
Barcham Green, J., Ltd. ccvii
Beck, R. & J., Ltd. ccvii
Beecroft & Partners, Ltd. cxcix
British Drug Houses, Ltd., The cxcix
British Electric Resistance Co., Ltd .. .. .. June
Chemapol clxxxvii
Classified Advertisements clviii
Cooke, Troughton & Simms, Ltd. cciv
Cuthbert, Ralph, Ltd. cxcvii
Datum Metal Products, Ltd. clxxxix
Davey & Moore, Ltd. cciii
Difco Laboratories, Inc. .. .. .. Cover iv
Distillers Company, Ltd., The cxc
Electrothermal Engineering, Ltd. .. .. .. June
Elliott, H. J., Ltd. .. .. August
Englehard Industries, Ltd. .. .. August
Esco (Rubber) Ltd. ccviii
Evans Medical Supplies, Ltd. cc
Gallenkamp, A. & Co., Ltd. .. .. .. Cover ii
Gerrard, T. & Co., Ltd. ccii
Griffin & George, Ltd. cci
Gurr, Edward, Ltd. ccvi
Hawksley & Sons, Ltd. ccv
Hearson, Charles & Co., Ltd. cxcii
Hopkin & Williams, Ltd. .. .. .. Cover iii
International Combustion Products, Ltd. cxci
Isopad, Ltd. .. .. August
Jacobson Van Den Berg & Co. (U.K.), Ltd. .. ccii
Jones, Samuel & Co., Ltd. cciv
Laboratory Glassblowers Co., Ltd. cxcvii
Light, L. & Co., Ltd. .. .. June
London Office Machines, Ltd. .. .. .. July
Loughborough Glass Co., Ltd. clxxxv
Manesty Machines, Ltd. cxciv
May & Baker, Ltd. cxc
Measuring & Scientific Equipment, Ltd. .. .. August
E. Merck, A. G. ccvi
Moncrieff, John, Ltd. clxxxvi
Morbank, Ltd. cciv
Newport Instruments (Scientific & Mobile), Ltd. .. cxcvi
Orme Scientific, Ltd. cxciv
Oxo Limited, (Medical Dept.) cxciii
Pascall Engineering Co., Ltd., The .. .. cxcviii & ccii
Permutit Co., Ltd., The .. .. .. August
Savage & Parsons, Ltd. .. .. .. August
Scorah, L. V. D., M.Sc. ccvi
Shandon Scientific Co., Ltd., The cxcviii
Siemens Edison Swan, Ltd. cxcv
Short & Mason, Ltd. .. .. June
Spencer Components ccviii
Springham, G. & Co. ccii
Stabilag Co., Ltd., The .. .. July
Stanton Instruments .. .. August
Swift, James & Son, Ltd. ccv
Taylor Rustless Fittings Co., Ltd. ccv
Thermal Syndicate, Ltd., The clxxxviii
Towers, J. W. & Co., Ltd. cxcii
Watson, W. & Sons, Ltd. cciii
Wild-Barfield Electric Furnaces, Ltd. .. .. August
Zeal, G. H., Ltd. cxcviii

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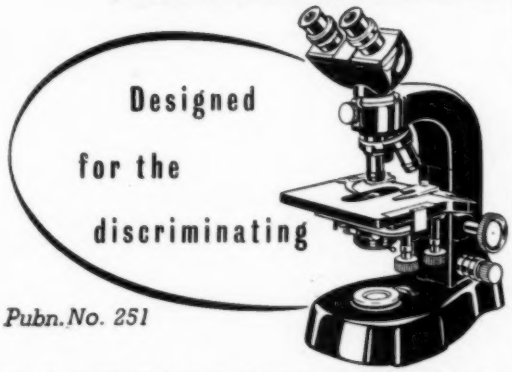

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